ARMY RESEARCH LABORATORY

Maintainability Survey for the High Mobility Multipurpose Wheeled Vehicle (HMMWV)

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Abstract

Maintenance operations influence vehicle effectiveness during the full range of required missions. These operations are essential to ensure that the vehicle systems are mission ready and coincide with the needs of the soldier.

In order to identify maintainability-related shortfalls for the high mobility multipurpose wheeled vehicle, a survey was conducted of 89 field site maintenance personnel.

The primary problems identified during this survey were troubleshooting preferences, the need for improved component access, time-consuming fasteners and connectors, lifting and carrying difficulties, problems with labels and marking, and operational checks.

It is recommended that new vehicle systems take these items into consideration to enhance maintenance operations thus to increase mission performance and to reduce operation and sustainment costs.

ACKNOWLEDGMENTS

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CONTENTS

EXECUTIVE SUMMARY

Maintenance operations influence vehicle effectiveness during the full range of required missions. These operations are essential to ensure that the vehicle's systems are mission ready and coincide with the needs of the soldier. In order to identify maintainability problems for the high mobility multipurpose wheeled vehicle (HMMWV), the Human Research and Engineering Directorate, Tank-Automotive Command (TACOM) Field Element, of the U.S. Army Research Laboratory conducted a survey of 89 field site HMMWV maintenance personnel. The goal of this study was to assess the maintainer-machine interface for the HMMWV and identify lessons learned, which are applicable to the development of current and future military wheeled vehicles.

The study addressed maintenance access, troubleshooting, tools and test equipment, safety, effects of clothing, connectors, fasteners, labeling, lifting and carrying, operational checks, technical manuals, training, personnel requirements, and removal and replacement of components through field site surveys of the personnel who maintain fielded HMMWVs. A questionnaire was completed by a mix of military occupational specialties, such as 63B Light Wheeled Vehicle Mechanic, 63E M1 Abrams Tank System Mechanic, 63S Heavy Wheeled Vehicle Mechanic, and 63Y Tracked Vehicle Mechanic. These data were collected and examined to determine the nature and frequency of each area of concern, as well as the difficulty of each operation described.

The primary problems identified during this survey included troubleshooting preferences, the need for improved component access, time-consuming fastener and connector usage, lifting and carrying difficulties, problems with labels and marking, and operational checks. It is recommended that new vehicle systems take these items into consideration to enhance maintenance operations and to contribute to mission performance and reduce operation and sustainment costs. This could be accomplished by minimizing manpower and training costs and by reducing the potential for personnel injuries and damage to equipment. Additionally, logistics resources, such as tools, test equipment, and spare parts may be used more effectively when the system has been designed for easy maintenance.

MAINTAINABILITY SURVEY FOR THE HIGH MOBILITY MULTIPURPOSE WHEELED VEHICLE (HMMWV)

INTRODUCTION

Effective Maintenance

The Contribution of Maintenance to Mission Performance

Effective maintenance by properly trained personnel, who are using modern diagnostic equipment and tools, is essential in sustaining military vehicles during the full range of required missions. The needs of wheeled vehicle maintenance units must be met in an effective and timely manner to ensure success during mission performance. System readiness requires effective application of maintenance personnel and equipment to keep the vehicle and its systems operational. Failure to properly maintain military assets has the same effect as losing such assets to enemy actions.

Operation and Sustainment Cost Reduction

Since wheeled vehicle maintenance units are oriented to provide timely support, it is important to ensure that the vehicle that must be maintained provides a satisfactory soldier-machine interface, so that quick and easy support is possible. If it is necessary to remove other (obstructing) components before a failed unit can be replaced or tested, then the soldier-machine interface is inadequately applied to the design of the system. If the original vehicle design specification addresses ease of maintenance as a design goal, the life cycle cost of overall vehicle operation and sustainment will be reduced. Vehicles that are originally designed for safe, easy, and effective maintenance and troubleshooting enhance overall soldier and mission performance. Maintainability programs that address the relationship between maintenance and its various operation and sustainment costs (e.g., manpower, personnel and training) will field more cost-effective systems. Additionally, logistic resources, such as tools, test equipment, and spare parts are used more effectively if such concerns are considered in relation to other aspects of the overall design.

Manpower and Personnel Integration (MANPRINT)

An important part of the effort to develop easy-to-maintain, cost-effective systems is the Army's manpower and personnel integration (MANPRINT) program. This program is intended to enhance the design of Army systems by addressing the skills, abilities, and performance limitations of personnel who are involved in the operation and maintenance of its

systems. This is accomplished through careful integration of the seven domains of MANPRINT (i.e., manpower, personnel, training, human factors engineering, system safety, health hazards, and soldier survivability) into the acquisition process of Army systems to ensure that effective operation and maintenance are realized during fielding. One important step in the MANPRINT process is the identification of maintainability shortfalls of fielded systems. The identification of these shortfalls can result in lessons learned for emerging systems and modifications of existing systems. It is important, therefore, that lessons learned data be applied to systems during development and modification to ensure that cost-effective, maintainable systems are produced.

HMMWV MAINTAINABILITY SURVEY

Purpose of the Survey

In order to identify maintainability concerns that should be avoided in future wheeled vehicle systems, the Human Research & Engineering Directorate, Tank-Automotive Command (TACOM) Field Element, of the U.S. Army Research Laboratory (ARL) conducted a survey of 89 high mobility multipurpose wheeled vehicle (HMMWV) maintenance personnel. This survey identified lessons learned, which are applicable to the development of future military wheeled vehicles. These lessons learned will help identify and quantify design, training, maintainer staffing and personnel equipment shortfalls that can be eliminated or reduced to acceptable levels during system modification and can be avoided on new systems. Improving maintainability for wheeled vehicle operations will help to minimize maintenance task times, optimize vehicle availability, enhance maintainer safety, and reduce overall operation and sustainment costs.

Survey Development

This survey is based on questionnaires administered to HMMWV maintenance personnel in the field. It employs the format developed by ARL's Field Element in Fort Rucker, Alabama, where a similar study of the AH-64 Apache attack helicopter (Durbin & Armstrong, 1996) was performed. The differences between a helicopter and a wheeled ground vehicle are obvious, but the similarities between the basic approaches to maintaining these vehicles are significantly parallel. The maintainers for each vehicle must access, troubleshoot, remove, and replace components that are often awkward to handle and exceed one-person lift requirements. These components are not always properly described in the technical data provided and are not always easily diagnosed with the test equipment available. The tools provided to the maintainer are not always appropriate, and sometimes the personnel have received less than the desired training. There are instances when bulky protective clothing must be worn during maintenance procedures,

which makes delicate operations awkward and generally inhibits the maintenance process. The HMMWV (see Figure 1) is a relatively basic wheeled ground vehicle, which is more sophisticated than its predecessor (the Truck, Utility, 1/2-ton, 4 x 4, M151A1, i.e., Jeep), but like its predecessor, it consists of basic automotive components which in themselves are relatively easy to maintain. The problems encountered during HMMWV maintenance have to do with accessing, troubleshooting, and replacing components when other components sometimes have to be removed for access or access is awkward and time consuming. This survey discusses the extent of such problems and possible solutions to resolve them.

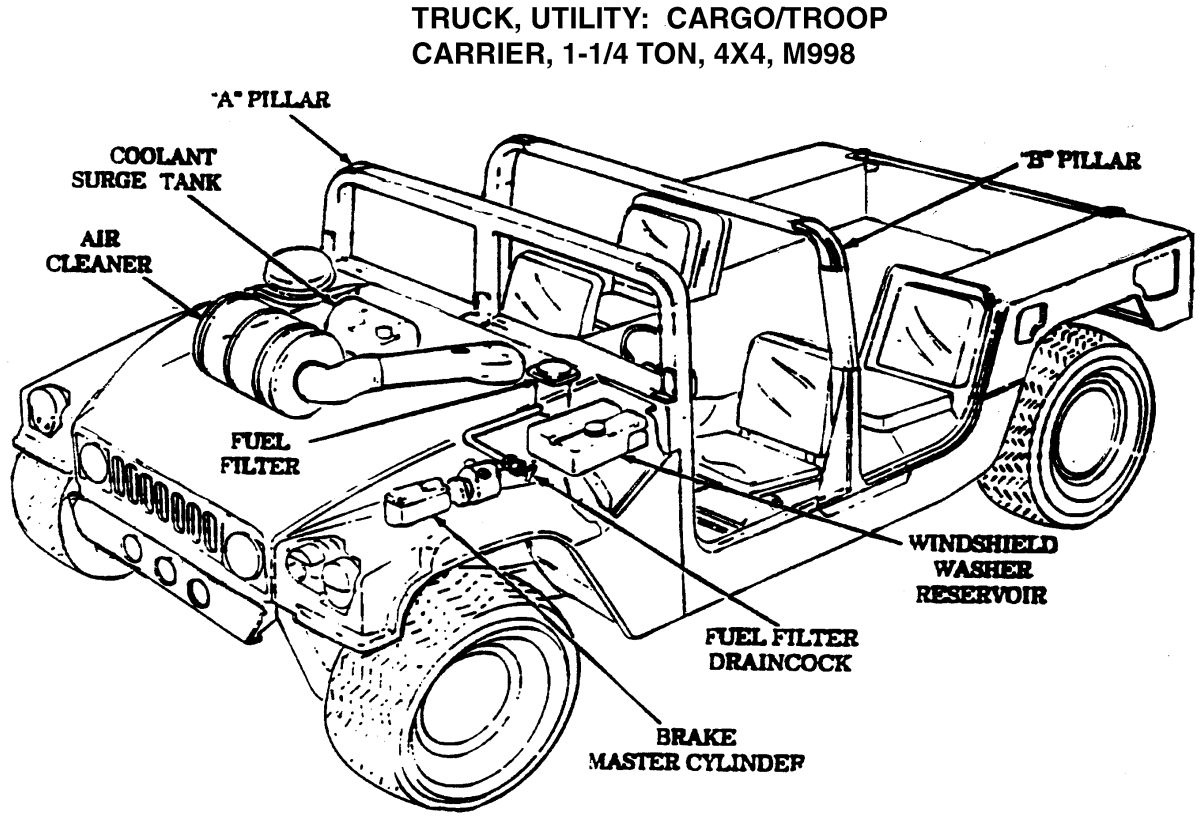

Figure 1. HMMWV: Major components.

After its initial development, the content of this survey was reviewed by knowledgeable personnel at the new equipment training facility at TACOM, where variations in format and revisions in content were finalized.

Data Collection

This survey was administered to HMMWV maintenance personnel at Aberdeen Proving Ground (APG), Maryland, and Fort Knox, Kentucky. At APG, the survey was given to graduating students at the U.S. Army Ordnance Center and School, who had just completed the Basic Noncommissioned Officer's Course for Wheeled Vehicles. Their military occupational specialty (MOS) was 63B20 (E5). At Fort Knox, the survey was given to personnel attached to the 2-81 Armor Unit, Armored Training Brigade. Their MOSs were a mix of 63B Light Wheeled Vehicle Mechanic, 63E M1 Abrams Tank System Mechanic, 63S Heavy Wheeled Vehicle Mechanic, and 63Y Tracked Vehicle Mechanic, all E-4 through E-6, who maintain the HMMWV.

The principal MOS surveyed was the 63B. The maintainers were assembled at the various sites and received a briefing from ARL personnel regarding the purpose of the survey. It was explained that the intent of the survey was to determine the characteristics of the systems and components that either enhance or degrade maintainer performance. Furthermore, it was explained that we were interested in collecting these data from personnel who actually maintain the vehicle in the field. They were told of the importance of providing accurate answers in an operational context since the data obtained would be used to assist in updating current vehicles, as well as in the design of future vehicles.

Data Analysis

After the survey data were collected from the field, they were analyzed at the ARL TACOM Field Element to determine the nature and frequency of each area of concern, as well as the relative difficulty of the operation described. The quantitative survey data from the questionnaires, which included rating scale responses, frequency responses, specific component problems and demographic information, were collated to examine and compare each response. The areas surveyed included troubleshooting, accessibility, removal-replacement, connectors-fasteners, labeling, tool-test equipment, effects of clothing, safety, and overall difficulty of maintenance. Question narratives and comments provided by the maintainers were transcribed verbatim from the individual surveys onto the comment data sheets for each MOS, in which similar comments were grouped according to specific components or problem areas (see Appendix A).

THE HIGH MOBILITY MULTIPURPOSE WHEELED VEHICLE

General Description

The HMMWV is a 1-1/4-ton, 4 x 4 (M998 series) tactical vehicle, which is designed for use over all types of roads, as well as cross-country terrain, during all weather conditions. The vehicles have four driving wheels powered by a V-8 liquid-cooled diesel engine. Four-wheel hydraulic service brakes and a mechanical parking brake are common in all models in the M998 series. All vehicles are equipped with a pintle hook for towing. Tie-down and lifting eyes are provided for air, rail, or sea transport.

The HMMWV accommodates a driver and one to three passengers, depending upon the model. The HMMWV variations include truck utility cargo-troop carrier (M998); truck utility towed carrier armored (M966); truck utility armament carrier (M1025); armored truck utility S250 shelter carrier (M1037); and truck ambulance two (M996), and four (M997) litter variations.

System Description

The HMMWV is composed of several specific systems as described next:

Structure—The M998 vehicle structure consists of steel frame rails, a heat-treated aluminum alloy body and a fiberglass hood and engine access cover. This structure supports and houses the vehicle components and personnel during mission performance over designated terrain.

Engine system—The M998 series of vehicles is powered by an eight-cylinder, four-cycle, liquid-cooled diesel engine. This engine provides power to a four-wheel drive which is controlled by the driver through gear selection.

Cooling system—The engine cooling system consists of a water pump, radiator, fan, and engine oil cooler. This system maintains prescribed engine temperatures by removing combustion heat through coolant circulation and radiation.

Electrical system—The electrical system includes power sources (battery and alternator), ignition system (wiring and glow plug system), engine starter, vehicle lighting (including blackout lights), and appropriate harnesses. It provides all electrical power requirements for the vehicle.

Steering system—This includes driver-controlled linkages with a power steering pump and connecting hoses. This system allows the driver to control the vehicle's direction.

Brake system—The brake system includes a brake master cylinder, service and parking brake controls with actuators and connecting lines. When the driver operates the service or parking brake control, the brake mechanism stops wheel rotation.

ARMY MAINTENANCE STRUCTURE

Army maintenance activities are organized to provide the user with the maximum number of safe, mission-capable vehicles. This is accomplished through a dedicated maintenance system, which includes unit, direct support, and general support activities.

Unit Support Maintenance

Unit support maintenance personnel perform preventive and scheduled services, visual inspections of components, cleaning, tightening, mechanical adjustments, and minor diagnosis and repair of easily detected equipment faults. This is accomplished using authorized tools and test equipment, when maintenance of worn or faulty components does not require complex skills and equipment.

Direct Support Maintenance

Direct support maintenance is performed by personnel who are required to exhibit more advanced technical skills and use more advanced tools and test equipment than are available at unit support. Authorized actions include testing, diagnosis, repair and adjustment or replacement of faulty components, which can be accomplished effectively with the skills and equipment provided at this level.

General Support Maintenance

General support maintenance is provided through the theater supply system and includes major repairs of vehicle components and systems. Authorized maintenance activities include repair of components, such as engines, transmissions, and axles.

PERSONNEL TASKS AND RESPONSIBILITIES

The following are the primary tasks and responsibilities (Department of the Army, 1994) of maintenance personnel, by skill level, who completed this survey:

63B Light Wheeled Vehicle Mechanic

Major Duties—The light wheeled vehicle mechanic performs and supervises unit maintenance and recovery operations on gasoline and diesel fueled light wheeled vehicles. Duties for each MOS skill level are

MOS 63B-10—Troubleshoots and performs unit maintenance on internal combustion engines and accessories, power trains, and chassis components of light wheeled vehicles.

MOS 63B-20—Capable of performing duties just described and diagnosing malfunctions of light wheeled vehicles.

MOS 63B-30—Capable of performing duties just described, including supervision of unit maintenance of vehicles, material handling equipment, and tools. Supervises recovery operations.

MOS 63B-40—Capable of performing duties just described and provides technical guidance to subordinates.

MOS 63B-50—Capable of performing duties just described, with focus on administrative planning, scheduling, inspection, and training.

63E M1 Abrams Tank System Mechanic

Major Duties—The M1 Abrams tank system mechanic performs and supervises maintenance and recovery operations on the M1 tank, including automotive, turret, fire control and chemical protection systems. Duties for each MOS skill level are

MOS 63E-10—Troubleshoots and performs unit maintenance on automotive systems and components of M1 tank, recovery vehicle (M88/A1), M113 family of vehicles and 1/4-ton to 2-1/2-ton tactical trucks (includes HMMWV).

MOS 63E-20—Capable of performing duties just described and diagnosing malfunctions of automotive systems and components at unit maintenance level.

MOS 63E-30—Capable of performing duties just described including supervision of unit maintenance on designated systems.

MOS 63E-40—Capable of performing duties just described and provides technical guidance to subordinates.

MOS 63E-50—Capable of performing duties just described, with focus on administrative planning, scheduling, inspection, and training.

63S Heavy Wheeled Vehicle Mechanic

Major Duties—The heavy wheeled vehicle mechanic performs unit maintenance of heavy wheeled vehicles and material handling equipment. Duties for each MOS skill level are

MOS 63S-10—Troubleshoots and performs unit maintenance on internal combustion engines and accessories, power trains, and chassis components of heavy wheeled vehicles.

MOS 63S-20—Capable of performing duties just described and diagnosing malfunctions of heavy wheeled vehicles.

63Y Tracked Vehicle Mechanic

Major Duties—The tracked vehicle mechanic performs unit maintenance on tracked vehicles
in units other than self-propelled artillery, armored, or armored cavalry units. Duties for each MOS skill level are

MOS 63Y-10—Troubleshoots and performs unit maintenance on internal combustion engines and accessories, power trains, and chassis components of tracked vehicles.

MOS 63Y-20—Capable of performing duties just described and diagnosing malfunctions of tracked vehicles.

HMMWV SURVEY DEMOGRAPHIC DATA

The following demographic data for the personnel who completed the HMMWV maintenance survey include anthropometric and work experience information as reported by the maintainers. This information helps define the population characteristics of the personnel who participated in the survey.

63B Light Wheeled Vehicle Mechanic

The total number of 63B personnel surveyed was 65 individuals, these representative users ranged from 5th percentile female to 95th percentile male in anthropometric stature.

Rank	Female	Male	Total
MSG	0	0	0
SFC	0	0	0
SSG	0	1	1
SGT	5	57	62
CPL	0	0	0
SPC	0	1	1
PFC	0	1	1

Military Occupational Specialty (MOS)

63B50	0 (MSG)
63B40	0 (SFC)
63B30	1 (SSG)
63B20	62 (SGT)
63B10	2 (CPL-SPC-PFC)

Time Served in Rank

Average	5.2 years
High	10 years
Low	7 months

Time Served in MOS

Average	7 years
High	13 years
Low	14 months

Time Worked on HMMWV

Average	6 years
High	11 years
Low	1 year

Other Wheeled Army Vehicles Maintained by Those Surveyed

M939	53 63B personnel
M809	36 63B personnel
CUCV	14 63B personnel
FMTV	6 63B personnel

Reported Height

	Female	Male
Average	62 inches (20th percentile)	65 inches (10th percentile)
High	65 inches (65th percentile)	73 inches (95th percentile)
Low	60 inches (5th percentile)	57 inches (off the chart)

Reported Weight

	Female	Male
Average	135 pounds	190 pounds
High	167 pounds	240 pounds
Low	104 pounds	140 pounds

Reported Age

	Female	Male
Average	29 years	27.5 years
High	33 years	33 years
Low	25 years	22 years

63B personnel reported that they typically spent the following time on an average day in the following activities:

HMMWV Maintenance (overall)	60%
Non-maintenance training	15%
Non-maintenance administrative	15%
Other	10%

Other activities include

	No. of Comments
Attend briefings	1
Shop safety inspector	1
Shop equipment handling, ordering, training & cleaning	4
Retain current status for airborne operations	2
Work toward Master Driver's Badge	2
Noncommissioned Officer's Development Program	4
Participate in work details	6
Participate in classroom instruction (student-teacher)	3
Participate in promotion boards	2

63E M1 Abrams Tank System Mechanic

Total 63E personnel surveyed was nine individuals.

Rank	Female	Male	Total
MSG	0	0	0
SFC	0	0	0
SSG	0	1	1
SGT	0	5	5
CPL	0	0	0
SPC	0	3	3

Military Occupational Specialty (MOS)

63E50	0 (MSG)
63E40	0 (SFC)
63E30	1 (SSG)
63E20	5 (SGT)
63E10	3 (CPL-SPC-PFC)

Time Served in Rank

Average	2.5 years
High	3 years
Low	2 years

Time Served in MOS

Average	7 years
High	10 years
Low	4 years

Time Worked on HMMWV

Average	5 years
High	9 years
Low	1 year

Other Wheeled Army Vehicles Maintained by those Surveyed

M939	5 63E personnel
M809	6 63E personnel
CUCV	1 63E personnel
FMTV	0 63E personnel

Reported Height

	Female	Male
Average	0	68 inches (35th percentile)
High	0	73 inches (95th percentile)
Low	0	63 inches (2nd Percentile)

Reported Weight

	Female	Male
Average	0	172 pounds
High	0	210 pounds
Low	0	135 pounds

Reported Age

	Female	Male
Average	0	30 years
High	0	39 years
Low	0	21 years

63E personnel reported that they typically spent the following time on an average day in the following activities:

HMMWV Maintenance (overall)	30%
Non HMMWV maintenance training	15%
Non-maintenance administration	5%
Other	50%

Other activities include

	No. of Comments
Work details	2
Noncommissioned officer's development program	1
Working on other vehicles	9

63S Heavy Wheeled Vehicle Mechanic

Total 63S personnel surveyed was 11 individuals, who ranged from less than 1st percentile to 95th percentile, representative male user personnel.

Rank	Female	Male	Total
MSG	0	0	0
SFC	0	0	0
SSG	0	0	0
SGT	0	11	11
CPL	0	0	0
SPC	0	0	0

Military Occupational Specialty (MOS)

63S20	11 (SGT)
63S10	0 (CPL-SPC-PFC)

Time Served in Rank

Average	5.5 years
High	10 years
Low	1 year

Time Served in MOS

Average	8 years
High	12 years
Low	4 years

Time Worked on HMMWV

Average	5.5 years
High	10 years
Low	1 year

Other Wheeled Army Vehicles Maintained by Those Surveyed

M939	10 63S personnel
M809	5 63S personnel
CUCV	5 63S personnel
FMTV	1 63S personnel

Reported Height

	Female	Male
Average	0	67 inches (25th percentile)
High	0	73 inches (95th percentile)
Low	0	61 inches (off the chart)

Reported Weight

	Female	Male
Average	0	157 pounds
High	0	180 pounds
Low	0	135 pounds

Reported Age

	Female	Male
Average	0	31 years
High	0	36 years
Low	0	26 years

63S personnel reported that they typically spent the following time on an average day in the following activities:

HMMWV Maintenance (overall)	60%
Non-maintenance training	15%
Non-maintenance administrative	15%
Other	10%

Other activities include

	No. of Comments
Participate in work details	4
Shop safety	1
Promotion boards	1
Classroom instruction (teacher)	1

63Y Tracked Vehicle Mechanic

Total 63Y personnel surveyed was three individuals, who ranged from 30th to 90th percentile user personnel.

Rank	Female	Male	Total
MSG	0	0	0
SFC	0	0	0
SSG	0	1	1
SGT	0	3	3
CPL	0	0	0
SPC	0	0	0

Military Occupational Specialty (MOS)

63Y20	3 (SGT)
63Y10	0 (CPL-SFC-PFC)

Time Served in Rank

Average	2.5 years
High	3 years
Low	2 years

Time Served in MOS

Average	6.5 years
High	8 years
Low	5 years

Time Worked on HMMWV

Average	4.5 years
High	7 years
Low	2 year

Other Wheeled Army Vehicles Maintained by those Surveyed

M939	2 63Y personnel
M809	0
CUCV	1 63Y personnel
FMTV	0

Reported Height

	Female	Male
Average	0	69.5 inches (55th percentile)
High	0	72 inches (90th percentile)
Low	0	67 inches (30th percentile)

Reported Weight

	Female	Male
Average	0	177.5 pounds
High	0	200 pounds
Low	0	155 pounds

Reported Age

	Female	Male
Average	0	30 years
High	0	36 years
Low	0	24 years

63Y personnel reported that they typically spent the following time on an average day in the following activities:

HMMWV Maintenance (overall)	43%
Non HMMWV maintenance training	16%
Non-maintenance administration	11%
Other	30%

Other activities include

	No. of Comments
Master driver	1
Work details	1
Working on other vehicles	3

SUMMARY OF HMMWV MAINTAINABILITY SURVEY RESULTS

The following is a summary of the significant survey responses reported by the HMMWV maintenance personnel. A general overview of the maintainer responses is provided, along with examples of components and equipment that personnel reported they have difficulty maintaining. The responses are then summarized as lessons learned, followed by a discussion of the impact they have on the maintainability of the vehicle. Survey results are based on maintainer experience and therefore contain subjective information. Efforts to further quantify maintainer responses need to

be conducted. This includes performing trade-off analyses to determine the feasibility of changes in design, training, or maintenance procedures. The summary information contained in this section, as well as the complete survey results contained in the appendix will provide the HMMWV Program Manager and the wheeled vehicle community with a set of lessons learned, which can be applied to modifications of the HMMWV or to the design of emerging systems.

GENERAL OVERVIEW

Troubleshooting

When asked what problems they experienced when using the standard test equipment internal combustion engine (STE-ICE), several HMMWV maintainers reported that this equipment is bulky and time consuming to operate. They generally preferred to use a hand-held multimeter to resolve most of the problems that they encountered.

Accessibility

Several HMMWV maintainers reported that problems relating to component access were generally caused by insufficient work space (mostly in the engine compartment), interference from surrounding components, and difficulty in reaching components that were mounted in an awkward position. Maintainers suggested that the addition of access panels (e.g., over the fuel tank) and relocation of specific components (e.g., power steering pump) would improve maintenance operations.

Fasteners

The maintainers' response concerning their experience with HMMWV fasteners (e.g., latches, bolts, and screws) included a list of components that were considered difficult to secure using the means provided. This list identified items that were difficult to fasten in place (e.g., the engine hood) and were time consuming to replace (e.g., canvas cover-starter) and how often non-captive fasteners were dropped during maintenance. It was suggested that difficult component fasteners be replaced with quick release mechanisms to optimize task performance.

Connectors

When asked about the problems they experienced with HMMWV connectors, several maintainers reported that "old style" connectors (cannon plugs), such as used on the control box were outdated and should be replaced. It was reported that some wires could be reversed (e.g.,

power and ground lines for gauges are interchangeable) and that some wire lines were too short (e.g., fuel tank and tail light) for easy maintenance. Color coding and quick disconnects were recommended.

Labeling and Marking

Approximately one-half of all MOSs surveyed indicated that the HMMWV had problems with labels (i.e., missing, hidden, or difficult to read). No specific instances were recorded, although they had the opportunity to report this problem. There were no reports of inaccurate labels.

Lifting and Carrying

When asked about problems concerning lifting and carrying HMMWV components, several of the persons surveyed reported that several items were difficult to manipulate. This list included the starter, the battery, and the engine hood. It was suggested that even when a two-person lift was indicated by the weight of the object, there was not enough space to accommodate two people.

Remove and Replace

The maintainers surveyed indicated that several HMMWV components were time consuming to remove and replace. It was reported that items such as the starter, the alternator, and the “glo-plugs” did not provide a satisfactory soldier-machine interface and that various interference problems degraded task performance. The lack of an access cover to the fuel tank was a concern when the fuel sender unit and related items were replaced. The availability of parts and the suitability of order forms and records were also discussed.

Operational Checks

When asked about problems that they experienced while performing operational checks, several maintainers reported that the starter, generator, injection pump, and geared hub were the most difficult tasks. It was indicated that more modern test equipment (e.g., PRO-LINK 9000, power tools, and the inclusion of a 3/8-inch socket set) would improve maintenance task times.

Technical Manuals

The maintainers surveyed reported that the HMMWV technical manuals needed improvement (e.g., in individual component maintenance procedures, troubleshooting techniques, and a quick reference to solving common problems). It was suggested that the manuals be converted to tape or onto a computer and that if the manuals remain as they are, more illustrations are needed.

Training

When asked about problems regarding the military training they have received to maintain the HMMWV, 43% of those surveyed rated their training as "moderately adequate." No specific reasons were given for this rating, but most of the comments indicated that more extensive training was needed. It was indicated that maintenance was generally degraded when protective garments (e.g., mission-oriented protective posture [MOPP] IV) are worn.

Safety Problems

Several of the maintainers surveyed indicated that hot surfaces, sharp edges, electrical hazards, contact with moving parts, and fluid spills could degrade task performance. This is especially true during operational checks when equipment is active.

The Effects of Clothing

Approximately 75% of the maintainers surveyed had no experience with task performance while wearing protective clothing. Those with experience with MOPP IV, arctic, or combat gear indicated that it was difficult to work in restricted spaces (under hood-instrument panel) while wearing such garments.

Personnel Requirements

Several of the maintainers reported that for most tasks, they "never-sometimes" need more personnel than is specified in the technical manuals. Sometimes, such as for operational checks, they must have assistance to operate the vehicle controls, follow the test in the manual, or need extra hands to hold tools. Other times, extra people "just get in the way."

Tool Requirements

When asked about the tools that they need, which are not provided in their standard toolbox, several of the maintainers reported that they need “all the tools described the manual.” They suggested that mechanical aids (e.g., “lifts”) be incorporated to lift heavy items, such as the starter, which is difficult to manipulate during maintenance.

Test Equipment Requirements

When asked about the test equipment they need, which is not provided, several maintainers reported that they need better multimeters, a pressure tester, a load tester, and better diagnostic equipment, such as the PRO-LINK 9000, to replace the STE-ICE currently provided.

Overall Difficulty of Maintenance

When asked about the overall difficulty of maintenance, one-third of those surveyed rated it as “borderline.” They suggested that mechanics need more training in troubleshooting and recommended that several components (starter, glo-plug system, and power steering pump) need rethinking relative to both placement and mounting.

SUMMARY OF HMMWV LESSONS LEARNED

Table 1 lists the lessons learned from this maintainability survey for each area that was evaluated, with recommendations for improvements that could be made to increase soldier effectiveness.

Description of Lessons Learned

Troubleshooting

Lessons Learned—The diagnostic tools that are provided to maintain fielded equipment must not be so complex or bulky that the designated maintainer is unable to operate them effectively.

Discussion—The lack of a precise fault location system that is easy to set up has caused the designated HMMWV maintainer to partially reject the STE-ICE (43% never used STE-ICE) in favor of the more basic multimeter. It would appear that a more modern, user-friendly system (the PRO-LINK 9000 was suggested) should be employed to reduce troubleshooting

Table 1

Lessons Learned

Area	Improvements needed
Troubleshooting	Better equipment, training, manuals, and work space
Accessibility	Less restricted access to components (e.g., starter and fuel tank)
Fasteners	Standardized, captive, accessible fasteners
Connectors	Improved, foolproof, accessible, properly routed and identifiable connectors
Labeling-marking markings	Visible, understandable, not easily lost or damaged labels and
Lift-carry	Better user-to-component interface to enhance lift-carry; handles or mechanical means to manipulate
Remove-replace methods of handling each item	Improved access to components, connectors, and fasteners, with better
Operational checks	Start-up self-test capability and improved diagnostics
Technical manuals	Should contain more troubleshooting data, diagnostic charts, and diagrams with easy-to-understand text
Training	Improved instruction in basic maintenance procedures and common troubleshooting methods
Safety problems	Safety-oriented maintenance procedures that emphasize the use of correct methods and tools to perform a specific job effectively
The effects of clothing	Conduct training in basic maintenance while maintainer is wearing protective clothing. Include special techniques to overcome restrictions caused by clothing.
Personnel requirements	Include instruction in known methods to ease personnel workload. Introduce field-tested techniques known to experienced maintainers but not normally offered in schools.
Tool requirements	Improve availability of quality tools and instruction in proper usage of such tools
Test equipment in the proper use of such equipment	Improve availability of quality test equipment and provide instruction
Overall difficulty of maintenance	Improve overall access to components, fasteners, and connectors within the vehicle and provide more visible test points and labels

task times during the detection of fault conditions. The maintainers recommended that although they generally prefer a multimeter, its use would be enhanced if a more sophisticated model were available and longer leads were provided. They generally thought that no other MOS should be required to do the work they currently perform but had a list of suggestions that they thought would enhance their ability to perform troubleshooting. This list included more intense training for mechanics, better schematics, better fault isolation charts within better manuals, and improved work space to employ improved diagnostic equipment and tools.

Accessibility

Lessons Learned—The trade-offs that occur during the design of a vehicle reflect the final configuration of that vehicle and may degrade maintenance because of the inadequate accessibility of various badly placed components.

Discussion—If trade-offs that favor one area of concern over another (e.g., compartment size, versus component placement) are made during the design process, the soldier-machine interface may be degraded and vehicle readiness may be reduced. Of the maintainers surveyed, 32% reported that connecting lines and hoses are damaged occasionally (19%) or frequently (13%) because of difficult access. The fuel tank, starter, alternator, power steering pump, engine fuel filter, fan shroud, exhaust system, dashboard, and glo-plug system are included as items that are difficult to access. In some cases, one component must be removed to access another component (power steering-generator, heat shield-manifold gasket, and fan clutch-radiator). Maintainers indicated that the most significant improvement that could be made would be to improve the glo-plug controller (TACOM is currently working this problem by completely redesigning the controller, using solid state components, to greatly increase its reliability and maintainability, so that the need to access it will diminish and it will operate more effectively).

Fasteners

Lessons Learned—The improper use of fastener type and usage or the mix of different kinds or sizes of fasteners on an individual vehicle can make component servicing and replacement difficult and time consuming.

Discussion—If fastener techniques are not properly considered during the design process, the maintainer may be burdened by having to carry a wide variety of different tools and then having to select the proper tool from the toolbox for each job performed on a given vehicle.

Of the maintainers surveyed, 36% indicated that the different types of fasteners currently used moderately (26%) or significantly (10%) slowed them during removal and replacement. Vehicle fasteners should be restricted to a given style (such as metric or standard), a given type (such as Phillips or slot head), and not require any special tools to get the job done. Whenever possible, quick disconnect type fasteners (such as DZUS [not an acronym] fasteners which require only a half turn to operate) should be used. These fasteners should be easily accessible and not allow the component to drop or be lost when it is released. The maintainers who completed the survey indicated that they drop about 17% (on average) of the non-captive fasteners during normal task performance.

Connectors

Lessons Learned—Properly engineered components and their connecting wires, lines, hoses, and so forth, are a significant factor in overall mission performance, and improvements in this area can reduce vehicle down time.

Discussion—Connectors between components on military vehicles should be configured for quick and easy attachment and removal. They should remain firmly connected after installation and be easily identifiable by the maintainer. Connectors should not interfere with task performance because of awkward length, inflexibility, routing factors, or attachment difficulties. It should be physically impossible to attach a given connector to the wrong receptacle. Of those surveyed, 15% reported that the HMMWV had electrical and other connectors that could be connected incorrectly. A review of these problems includes the fact that external lighting circuits can lose tags and be incorrectly connected. (Comment: The current path through a vehicle exterior lighting circuit is usually not critical but could lose function if improperly connected.) The wires for the transmission neutral switch and the parking brake lamp switch can be interchanged. (Comment: These wires are labeled but use the same type of connectors so that a careless hook-up is possible. If they are interchanged, the operator would not be able to start the engine.) The Project Manager is investigating this problem and may issue a bulletin. Fuel pump vent and air cleaner vent are interchangeable. (Comment: Usually, vent lines are not critical unless they are disconnected or are plugged.) Power and ground lines for gauges are interchangeable. (Comment: Usually, gauges will not work if their two-wire connector is backwards.) Of those surveyed, 16% indicated that connector routing paths for the instrument panel wiring, tail light wiring, and fuel tank lines did not have adequate service loop. These problems probably could be alleviated by increasing line length.

Labeling-Marking

Lessons Learned—When the labels that are associated with components or their connecting lines are missing or are difficult to read or understand, maintenance task time will be increased, since each item to be diagnosed must be located before the maintenance process can begin.

Discussion—Identifying components and their connecting lines is important during the design process. Each item should be identified through a readily understandable system of words, symbols, colors, or numbers so that it can be easily seen by the maintainer from a normal viewing position. Identification should be an integral part of the item so that it is not easily lost or damaged. If words are used for identification, they must be understandable by the full range of potential user personnel (North Atlantic Treaty Organization). If symbols are used, they must be recognizable and must conform to a standard system of symbols agreed upon by all potential user personnel. The identification used should be easily understandable when it is traced in a manual or on a schematic. If color coding is used, it should comply with known codes already in existence. Those surveyed indicated that labels were difficult to read when the MOPP IV face mask was worn.

Lifting-Carrying

Lessons Learned—The maintainer machine interface that a vehicle represents is often defined by the ability of a designated maintainer to manipulate the component parts of that vehicle during maintenance operations.

Discussion—The ability of the HMMWV maintainer to lift and carry vehicle components depends upon many factors (e.g., the percentile size and strength of the soldier, the weight of the component, the size and shape of the component, and any obstacles adjacent to the mounted component within the work space). An object such as the starter or the battery is difficult to reach and lift from within the confines of the HMMWV engine compartment because of its position among other components and also because of its weight. Of those surveyed, 8% indicated that they needed a mechanical lift or appropriate handles to aid during component removal. They suggested that floor jacks be provided. They also suggested the addition of power tools, such as impact wrenches for faster removal-installation times. Of those surveyed, 11% suggested that alternate methods may be employed to reduce maintenance times. One suggestion was to slide the transmission back on its bolts for easier flywheel removal. Such techniques should be investigated by knowledgeable personnel to evaluate the worthiness of the suggestion.

Remove-Replace

Lessons Learned—Removal and replacement of components that are heavy or cumbersome or are confined to a small space within the work space can increase maintenance times and reduce vehicle readiness.

Discussion—Component replacement can be made unnecessarily difficult if a bulky or heavy component is placed in a remote or otherwise difficult-to-access location and is secured

by difficult-to-reach fasteners and connecting lines. Those surveyed indicated that the following items were difficult to remove-replace: starter, alternator, glo-plugs, fuel tank, geared hubs, power steering pump, radiator, ball joints, exhaust system, manifold gasket, differential seals, engine oil cooler, transmission oil cooler, and half-shaft. Fifty percent of the maintainers reported that (occasionally 37%) or (frequently 13%) the replacement parts were not available at their duty station and they had to wait several days or more to receive parts. They also reported that the ordering forms (e.g., FORM 5899E) should be revised to implement usage. They reported that the following improvements should be incorporated in the manuals: more illustrations, stock number placed on the same page as the part number, and an index of changes approved for the manual.

Operational Checks

Lessons Learned—The inability to quickly inspect components increases maintenance times and vehicle down time.

Discussion—Improving the maintainers' ability to do the task at hand by providing readily accessible components and check points will enhance the overall maintenance process. Those surveyed reported that the most difficult components to perform operational checks on were the starter, generator, injector pumps, geared hub, the glo-plug control box, and the radiator. Of those surveyed, 19% indicated that the following equipment would aid them in improving their task performance: PRO-LINK 9000 diagnostic equipment and power tools (e.g., torque wrench, battery load tester, fuel tank gauge sending tester, and central tire inflation system tester). They further suggested that the following significant improvements could be incorporated into the HMMWV, which would enhance the operational check process: provide self test for all vehicle components when vehicle is initially turned on, improve and extend mechanics' training, and provide better tools and test equipment.

Technical Manuals

Lessons Learned—The manuals provided for fielded vehicles must not be complex. Such manuals must use readily understandable language, which is accompanied by appropriate illustrations and charts that thoroughly interpret the message that is being presented.

Discussion—The method used to inform the maintainer concerning what has to be done to keep the vehicle operational must be completely understandable to the full range of designated maintainers. The method of delivering this message can be paper manuals, audio-visual tape, computers, or individual personal instruction, but it must support good vehicle maintenance. The manual should highlight what is taught in military maintenance schools and

augment those data to resolve any problem encountered in the field. It should provide complete troubleshooting data, which are based on the test equipment and tools available. Diagnostic charts of common problems and how to resolve them should be included. There should be an index that provides more basic data for inexperienced personnel or as a refresher for the experienced mechanic. These manuals should be light and easy to refer to, so they are always available when needed. Of those surveyed, 28% reported that the manuals provided were difficult to follow or did not have adequate instructions and diagrams. Nineteen percent reported that procedures and equipment were inadequate, but 100% said that safety warnings were adequate.

Training

Lessons Learned—Training should be based on the fundamental principles that make the component work. Basic electricity should be understood before the student delves into troubleshooting a starter, a glo-plug controller, or other electrical component.

Discussion—As time constraints and funding become more important within the military community, class time devoted to basics begins to shrink. If the maintainer has not been taught the basics and does not understand the fundamental concepts upon which a component or system depends for its operation, he or she cannot be expected to make intelligent decisions during the maintenance process. If the wrong decision is made, expensive damage may occur, or man-hours may be lost through "hunt and peck" maintenance techniques. Replacing "black boxes" can expedite some simple maintenance procedures but will not help if the problem runs beyond basic component replacement, where an understanding of fundamentals is necessary. Eventually, someone must repair that black box or take the expensive path of discarding it. Forty-three percent of maintainers reported that the training they received for the HMMWV maintenance was borderline (19%), moderately inadequate (16%), or very inadequate (8%). Fifty-nine percent of those surveyed had never performed maintenance while wearing protective gear, such as MOPP IV-combat-arctic clothing. When asked about alternate methods concerning training, one maintainer suggested using the experiences of "old timers" in the school's lesson plans.

Safety Problems

Lessons Learned—Any potential safety hazard on a vehicle, such as hot or sharp surfaces, fluid spills, or electrical problems, can increase the overall maintenance time. Such hazards may cause actual personnel injuries, resulting in lost man-hours, or may degrade task performance because of the maintainer's apprehension about the possibility of such injuries because he or she has seen or heard of it happening to others.

Discussion—Vehicles should be designed with safety in mind so that the resultant soldier-machine interface for both the operator and the maintainer is as good as it can be. Warnings and cautions about known safety problems must be provided as decals at the site of the potential hazard, as well as in manuals. Injuries from such hazards are less likely to occur in a well-lit shop area where the soldier is relatively fresh and has all the right tools and equipment to do the job, than in the field where the maintainer may be fatigued and have only the basic tools available. Approximately half of those surveyed reported that they had experienced problems with hot surfaces. Forty percent reported experiences with sharp edges and electrical hazards, whereas 32% reported experiences with moving parts or fluid spills.

The Effects of Clothing

Lessons Learned—Problems were experienced when the maintainers surveyed wore protective clothing. If a task is normally difficult to perform in fatigues or coveralls in a work space, it becomes more difficult when protective clothing is worn.

Discussion—The restricted movement and bulkiness of protective clothing amplifies the problems associated with vehicle maintenance. Furthermore, protective garments such as MOPP IV must be cooled to prevent heat stress if they are worn for prolonged periods. The cooling hoses and so forth further restrict dynamic task performance. The MOPP IV face mask makes it difficult to read nomenclature and labels. The efforts to improve the soldier-machine interface for the HMMWV work spaces should be a step toward improving task performance in protective clothing. About 70% of those surveyed had no experience performing maintenance while wearing MOPP IV-arctic clothing. Fifty percent reported no maintenance experience while wearing combat gear. Most maintenance was performed by those surveyed while they wore coveralls or fatigues, when only minor problems with clothing were indicated but not discussed.

Personnel Requirements

Lessons Learned—When the weight of an object exceeds individual human strength capability, or the number of “hands” needed to perform a task exceeds one individual’s capability, additional people must be available to complete a given task.

Discussion—The designated requirements prescribed for HMMWV task performance appear to be relatively simple when compared to those for some other more sophisticated vehicles. However, the compact design of the HMMWV often requires that personnel perform beyond their individual percentile limits in such areas as strength and reach.

Future designs must consider the soldier-machine interface to reduce the workload for the individual maintainer. The maintainers surveyed reported that generally they needed more people than was specified in the technical manual to do some close heavy lifting tasks (e.g., remove-replace starter) but that there was no space for more people. Only during carrying procedures was there sufficient space for more people, but the distance carried was not far enough to warrant help in most cases (e.g., distance from HMMWV to other transport).

Tool Requirements

Lessons Learned—Maintenance task performance can be greatly enhanced if faulty components can be removed and replaced quickly by well-trained personnel using the best tools available.

Discussion—It is usually cost effective to provide the best tools available to maintenance personnel in the field. A relatively simple task can be prolonged and frustrating to the maintainer if a badly designed tool is used. Such a tool may be difficult to employ properly because of its own bad design or because it does not allow direct access to the fastener securing the component. Those surveyed reported that they needed "all the tools in the manual" to do their job properly. They especially needed a 3/8-inch drive ratchet, Allen wrench sockets, and longer wrenches. They needed "some kind of lift" when mounting the starter and a wheeled creeper for under-vehicle inspections.

Test Equipment Requirements

Lessons Learned—If appropriate test equipment is not available to the maintainer in the field, the work will get done using the available equipment, but vehicle down time will increase.

Discussion—As with good tools, good diagnostic equipment is cost effective to reduce vehicle down time. If a trained maintainer can pinpoint a fault in a relatively short time span through the use of modern test equipment, more overall work will be accomplished in a shorter time and more vehicles will be available for missions. Those surveyed reported that they need better multimeters, a pressure tester, and overall better diagnostic equipment, such as the PRO-LINK 9000 to replace the STE-ICE currently provided. They also need a centralized diagnostic panel of test points, which is highly accessible and built into the vehicle.

Overall Difficulty of Maintenance

Lessons Learned—Operational checks and services and other maintenance tasks

should be made easier to perform. The technology is available that would allow the maintainer to check various system functions at the touch of a button.

Discussion—Any HMMWV product improvement program, as well as any emerging new vehicle system, must consider the problems associated with vehicle maintenance. For example, operational maintenance checks and procedures may require the soldier to probe for test points or fasteners in a cramped, dark space (under the hood) while the vehicle engine is running. In this situation, the maintainer is exposed to moving engine parts, electrical hazards, and hot surfaces. There is also the concern of lighting the problem area. If the maintainer must grasp a flashlight in one hand while probing with the other hand for a fault, progress will be delayed. If a helper is used, there may not be enough space for him or her to stand. Personnel injuries received during maintenance could be reduced if more thought were given to the welfare of maintenance personnel early in the design. Those surveyed reported overall difficulty of HMMWV maintenance as shown in Table 2.

Table 2

Overall Difficulty of HMMWV Maintenance

	Very difficult (percent)	Moderately difficult (percent)	Borderline (percent)	Moderately easy (percent)	Very easy (percent)
Troubleshooting	13	17	27	27	16
Accessing components	15	16	26	28	15
Fastening-unfastening	4	25	28	25	18
Connecting-disconnecting	0	19	27	35	19
Lifting-carrying	0	19	29	29	23
Removing-replacing	0	28	48	24	0
Operational checks	0	23	36	21	20

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APPENDIX A

HMMWV MAINTAINABILITY SURVEY RESULTS

Troubleshooting

TS-1 How often do you use the STE-ICE when troubleshooting the HMMWV? The following rating scale response was provided by all MOSs participating:

Never	43%
Seldom	41%
Occasionally	13%
Frequently	3%

The following 42 comments were provided by MOS 63B personnel:

Never used STE-ICE (ten comments)
Seldom used STE-ICE (ten comments)
STE-ICE procedures are often easily substituted by using hand-held multimeter or test light (ten comments)
STE-ICE is bulky and time consuming to use (four comments)
It takes too long to set up STE-ICE (three comments)
Soldiers need more training on STE-ICE (two comments)
Suggest that the more modern PRO-LINK 9000 be adopted (two comments)
Faults are difficult to locate with STE-ICE (one comment)

The following 11 comments were provided MOS 63S personnel:

Seldom used STE-ICE (eight comments)
Never used STE-ICE (three comments)

The following three comments are provided by MOS 63Y personnel:

Never used STE-ICE (three comments)

The following nine comments were provided by MOS 63E personnel:

Never used STE-ICE (five comments)
Most problems are easier to detect with a multimeter (two comments)
Received very little training in the use of STE-ICE (one comment)
It is easier to work a problem without “hauling out” STE-ICE (one comment)

TS-2 Have you experienced any problems when using the STE-ICE for troubleshooting the HMMWV? The following rating scale response was provided by all MOSs participating:

Yes	30%
No	27%
Never used	43%

The following 40 comments were provided by MOS 63B personnel:

Never used STE-ICE (ten comments)
It takes too long to run tests with STE-ICE (ten comments)
Very little training is given on STE-ICE (five comments)
Set-up faults are hard to locate (four comments)
Test readings for STE-ICE were not consistent (three comments)
Calibration is time consuming on STE-ICE (three comments)
When double-checking results with STE-ICE, received error codes (one comment)
The STE-ICE at my shop is always inoperative (one comment)
STE-ICE is not user friendly (one comment)
STE-ICE led me to wrong diagnosis (one comment)
When it is a cold and rainy day, STE-ICE works poorly (one comment)

The following 11 comments were provided by MOS 63S personnel:

Seldom used STE-ICE (eight comments)
Never used STE-ICE (three comments)

The following three comments were provided by MOS 63Y personnel:

Never used STE-ICE (three comments)

The following nine comments were provided by MOS 63E personnel:

Never used STE-ICE (five comments)
Easier to use a multimeter (two comments)
Received inadequate training on STE-ICE (one comment)
Easier to work problems without STE-ICE (one comment)

TS-3 When using other methods to troubleshoot (such as a multimeter) for fault isolation on the HMMWV, what problems do you have? No rating scale was included with this question. The following comments were provided:

The following 15 comments were provided by MOS 63B personnel:

Many wires on HMMWV are missing identification numbers (two comments)
Troubleshooting glo-plug difficult (two comments)
It takes two mechanics to use multimeter for some tests (two comments)
Light system troubleshooting difficult (two comments)
Technical manual not specific concerning voltages at what pins (one comment)
Wiring diagram should be larger (one comment)
Not enough test leads provided (one comment)
Test leads are too short (one comment)
Cannot get to some test points with multimeter (one comment)

Alternator charging fault isolation difficult (one comment)
Fault isolation difficult for arctic heater (one comment)

The following three comments were provided by MOS 63S personnel:

When a multimeter is used, two pairs of hands are needed (one comment)
Improve wiring diagrams—hard to read (one comment)
Cannot get to some components with a multimeter (one comment)

No comments were provided by MOS 63Y personnel.

The following three comments were provided by MOS 63E personnel:

Difficult to troubleshoot vehicle lighting system (one comment)
Need more training on troubleshooting (one comment)
Problems with charging system difficult to isolate (one comment)

TS-4 Describe any troubleshooting tasks that you perform on the HMMWV that you feel should be performed by another MOS. List these tasks and why you feel another MOS should perform each task. No rating scale was included with this question. The following comments were provided:

The following 11 comments were provided by MOS 63B personnel:

A 63B should perform all tasks on a HMMWV short of major component overhaul (ten comments)
Transfer case output seal should be replaced by a 63W (one comment)

The following comment was provided by MOS 63S personnel:

Glo-plug troubleshooting should be taught to all MOS 63S personnel (one comment)

The following comment was provided by MOS 63Y personnel:

Replacing major assemblies should be a 63B task (one comment)

The following two comments were provided by MOS 63E personnel:

A 63E20 should be able to do the whole vehicle (one comment)
If you are trained on the HMMWV, you should be able to fix it (one comment)

TS-5 What are the most significant improvements that could be made in the HMMWV to reduce the time and effort required to troubleshoot systems and components? List improvements and expected time and effort reduction. No rating scale was included with this question. The following comments were provided:

The following 17 comments were provided by MOS 63B personnel:

Fuel tank sending unit inaccessible—need hatch over tank (three comments)
Need less interference from adjacent items during troubleshooting (three comments)
Mechanics need more training in troubleshooting (two comments)
Glo-plug system—make it easier to troubleshoot (two comments)
Need larger schematics to improve troubleshooting (two comments)
Need more space in engine compartment for troubleshooting (two comments)
Starter-alternator difficult to access for troubleshooting (two comments)
Need more comprehensive manuals to improve troubleshooting (one comment)

The following seven comments were provided by MOS 63S personnel:

Need PRO-LINK 9000 diagnostic system for HMMWV (two comments)
Need improved glo-plug system (two comments)
Starter-alternator difficult to troubleshoot (two comments)
Need more diagnostic training (one comment)

The following three comments were provided by MOS 63Y personnel:

Personnel heater difficult to diagnose (two comments)
Need quick disconnect for radiator hose (one comment)

The following four comments were provided by MOS 63E personnel:

Glo-plug controller needs improvement (three comments)
Brake pads hard to align and time consuming to change (one comment)

AC-1 List any HMMWV component where you do not have sufficient work space to reach that component and properly perform the tasks required to effectively service, replace, or maintain it. Describe problems for each component. No rating scale was included with this question.

The following 46 comments were provided by MOS 63B personnel:

Fuel tank sending unit needs hatch for access (ten comments)
Glo-plug access difficult (ten comments)
Starter-alternator difficult to access (eight comments)
Power steering pump inaccessible (six comments)
Engine fuel filter replacement (four comments)
Fan shroud difficult to remove (three comments)
Exhaust pipes at manifold tool access problem (two comments)
Access to oil pan bolts (one comment)
Parking brake cables (one comment)
Dashboard access to gauges (one comment)

The following nine comments were provided by MOS 63S personnel:

Starter removal difficult (three comments)
Difficult to access glo-plugs (two comments)
Power steering access (two comments)
Fuel filter replacement difficult (one comment)
Cross-over pipe at manifold (one comment)

The following two comments were provided by MOS 63Y personnel:

Require fuel tank access (two comments)

The following six comments were provided by MOS 63E personnel:

Glo-plugs access difficult (two comments)
Fuel tank needs access (two comments)
Hard to get at belts on generator (one comment)
Fan clutch hard to work on without removing radiator (one comment)

AC-2 List any HMMWV component where there is a significant interference from surrounding components, which degrades your ability to service, replace, or maintain that component. Describe problems for each component. No rating scale was included with this question.

The following 14 comments were provided by MOS 63B personnel:

Power steering pump—must remove generator (two comments)
Heat shield in way of glo-plug (two comments)
Arctic heater oil pan cover is close to starter (one comment)
Drive shaft in way of oil filter change (one comment)
Brake lines interfere with caliper wrench nut (one comment)
Fuel tank access (one comment)
Idler arm replacement—radiator hose interfere (one comment)
Manifold gasket—heat shield in way (one comment)
Lubricate universal joint on driveshaft (one comment)
Exhaust pipe in way when replacing starter (one comment)
Passenger seat dust boot blocks slave receptacle (one comment)
M997 ambulance generator in way of glo-plugs (one comment)

The following four comments were provided by MOS 63S personnel:

Power steering pump to generator interfere (two comments)
Run-flat tires hard to replace (one comment)
Temperature control valve hard to replace (one comment)

The following comment was provided by MOS 63Y personnel:

Glo-plug to heat shield problem (one comment)

The following two comments were provided by MOS 63E personnel:

Starter gear cover hard to replace (one comment)
Starter to exhaust pipe interference (one comment)

Accessibility

AC-3 List any HMMWV component that is mounted in an awkward position, which cannot be accessed until another major vehicle assembly or component is removed first. Describe problems for each component. No rating scale was included with this question.

The following five comments were provided by MOS 63B personnel:

Power steering pump—remove generator (one comment)
Fan clutch—remove radiator (one comment)
Manifold gasket—remove heat shield (one comment)
Remove radiator to work on engine (one comment)
Must remove flywheel cover and drive shaft for starter (one comment)

One comment was provided by MOS 63S personnel:

Power steering pump remove generator (one comment)

One comment was provided by MOS 63Y personnel:

Remove radiator to work on engine (one comment)

One comment was provided by MOS 63E personnel:

Remove radiator to work on engine (one comment)

AC-4 How often do HMMWV components, ancillary equipment, or connecting lines or hoses become damaged because they are difficult to access? The following rating scale response was provided by all MOSs participating:

Never	25%
Seldom	43%
Occasionally	19%
Frequently	13%

The following 14 comments were provided by MOS 63B personnel:

Brake lines bend during replacement (four comments)
The vent line on the fuel tank (three comments)
Transmission lines damaged when tightened (two comments)
Power steering lines stripped out (one comment)
Oil cooler lines during radiator removal (one comment)
Fan clutch hose (one comment)

Vent lines on axle hubs (one comment)
Heater hose at heater valve (one comment)

The following five comments were provided by MOS 63S personnel:

Transmission hose damaged when new belts installed (one comment)
Brake lines twisted at rear caliper (one comment)
Coolant cross-over tube breaks easily (one comment)
Fan clutch hose (one comment)
Vent lines at fuel tank and axle hub (one comment)

No comments were provided by MOS 63Y personnel.

No comments were provided by MOS 63E personnel.

AC-5 What are the most significant improvements that could be made in the HMMWV, to reduce the time and effort requirement to access components? Describe envisioned improvements. No rating scale was included with this question.

The following 32 comments were provided by MOS 63B personnel:

Fuel tank access—needs hatch (six comments)
Easier glo-plug removal (six comments)
Improve glo-plug controller (three comments)
Starter-generator access (three comments)
Need quick disconnects to improve maintenance (two comments)
Improve vehicle hood (two comments)
Better work space around engine (two comments)
Relocate power steering pump (two comments)
Improve brake line maintenance (two comments)
Exhaust manifold access (one comment)
Improve flywheel cover (one comment)
Improve gauge access at instrument panel (one comment)
Improve heat shield (one comment)

The following six comments were provided by MOS 63S personnel:

Find better location for power steering pump (two comments)
Fuel tank access (two comments)
Need engine side access panels (one comment)
Engine compartment work space (one comment)

The following three comments were provided by MOS 63Y personnel:

Fuel tank access (two comments)
Glo-plug controller (one comment)

The following two comments were provided by MOS 63E personnel:

Glo-plug controller needs improvement (one comment)
Fuel tank access (one comment)

Fasteners

FA-1 Which HMMWV fasteners (e.g., compartment cover latches, bolts, screws, tie downs, etc.) are difficult to fasten or unfasten during servicing, removal, or replacement procedures? List type of fastener, item that it holds, and explain difficulty experienced. No rating scale was included with this question.

The following 20 comments were provided by MOS 63B personnel:

Alternator-starter bolts (five comments)
Engine cover difficult to manipulate (three comments)
Canvas covers tie downs (three comments)
Brake caliper bolt removal (two comments)
"Doghouse" fasteners easily broken (one comment)
Screws on exhaust shield (one comment)
Master cylinder cover M1097 (one comment)
Flywheel cover should be two pieces (one comment)
Power steering cooler and oil cooler bolts strip easily (one comment)
Rear-view mirror fastening (one comment)
Wiper arm motor and linkage (one comment)

The following two comments were provided by MOS 63S personnel:

Cab and cargo canvas covers "don't fit right" (one comment)
Rear generator bracket mounting bolt to manifold (one comment)

The following comment was provided by MOS 63Y personnel:

Door handles hard to operate (one comment)

The following six comments were provided by MOS 63E personnel:

Engine cover hard to use (three comments)
Fasteners on doghouse (one comment)
Brake caliper room to remove bolt (one comment)
Window latches on doors—release latch window crashes down (one comment)

FA-2 Which HMMWV components would be easier and less time consuming to service or replace if captive fasteners (e.g., DZUS fasteners, nut plates, etc.) were incorporated into the design? List components and type of fastener currently used. No rating scale was included with this question.

The following 22 comments were provided by MOS 63B personnel:

Hood fasteners (five comments)
Canvas fasteners (four comments)
Fuel tank access (if provided in future design) (three comments)
Air filter housing (two comments)
Fuel filter housing (one comment)
Heat shield exhaust manifold (one comment)
Instrument panel (one comment)
Troop seats (one comment)
Reflectors (one comment)
Splash panel for front tires (one comment)
Radio mounting (one comment)
Hold down for generator wires (one comment)

The following two comments were provided by MOS 63S personnel:

Fuel filter housing (one comment)
Fuel tank access if provided (one comment)

The following two comments were provided by MOS 63Y personnel:

Make windshield removable (one comment)
Make fuel tank accessible (one comment)

The following one comment was provided by MOS 63E personnel:

Hood fasteners (one comment)

FA-3 Estimate the percentage of time that you accidentally drop or lose non-captive items (e.g., nuts, bolts, washers, reservoir caps, inspection covers, etc.) when servicing or removing HMMWV components.

0 to 10%	40%
10 to 20%	30%
20 to 30%	12%
30 to 40%	8%
50%+	10%

The following nine comments were provided by MOS 63B personnel:

Starter motor bolts (two comments)
Battery components (one comment)
Fuel filter housing (one comment)
Intake manifold (one comment)
Especially washers (one comment)
Radio mount screws (one comment)
Splash panel bolts (one comment)
Water pump bolts (one comment)

The following three comments were provided by MOS 63S personnel:

Hood fasteners (one comment)
Rear starter bolts (one comment)
Wiper motor parts (one comment)

The following comment was provided by MOS 63Y personnel:

Starter spacer (one comment)

No comments were provided by MOS 63E personnel.

FA-4 To what degree do different types of fasteners (e.g., Allen head, Phillips head, slot head, various wrenches, etc.) used to secure components or connectors, slow HMMWV service removal and replacement time (e.g., searching for correct tool etc.)?

Significantly	10% of time
Moderately	26% of time
Slightly	28% of time
None	36% of time

The following 17 comments were provided by MOS 63B personnel:

Exhaust manifolds (ten comments)
Gear hub drain plug (two comments)
Oil cooler bolts (one comment)
Differential plug (one comment)
Radio mounts (one comment)
Marker light screws (one comment)
Oil cooler-radiator (one comment)

The following two comments were provided by MOS 63S personnel:

Oil cooler bolts (one comment)
Exhaust mounting bolts (one comment

The following comment was provided by MOS 63Y personnel:

Fasteners should be either standard or metric (one comment)

The following comment was provided by MOS 63E personnel:

Exhaust manifolds (one comment)

FA-5 What are the most significant improvements that could be made in the HMMWV to reduce the time and effort required to fasten and unfasten components? List improvements envisioned and estimated time saved. No rating scale was included with this question.

The following seven comments were provided by MOS 63B personnel:

Starter should be removable without removing shroud (one comment)
Fuel filter needs quick release (one comment)
Have to remove radio to get at rear of engine (one comment)
Oil cooler needs quick disconnects (one comment)
Canvas need better fasteners (one comment)
Fan clutch needs quick disconnect (one comment)
Air cleaner needs buckles instead of clamps (one comment)

The following comment was provided by MOS 63S personnel:

Replace canvas covers with steel (one comment)

The following comment was provided by MOS 63Y personnel:

Need better method of securing air cleaner (one comment)

The following comment was furnished by MOS 63E personnel:

Better method of removing starter (one comment)

Connectors

CN-1 List any HMMWV connectors (e.g., electrical plugs, hose fittings, tube fasteners, etc.) that are difficult to connect and disconnect during servicing, removal, and replacement procedures. Describe problem for each connector. No rating scale was included with this question.

The following 22 comments were provided by MOS 63B personnel:

Top of control box needs better connector (five comments)
Brake line fittings at calipers strip easily (two comments)
Instrument panel gauges need better connectors (two comments)
Fuel tank lines and vent (two comments)
Get rid of hose—clamps replace with quick disconnects (one comment)

Gear hub vent tube hard to replace (one comment)
Surge tank hose (one comment)
Power steering pump needs quick disconnect (one comment)
Glo-plug connects crumble with heat (one comment)
Lighting wiring harness (one comment)
Temperature control valve hoses dry rot (one comment)
Starter wires (one comment)
Engine temperature sending unit (one comment)
Vent on top of differential (one comment)
Oil cooler needs quick disconnects (one comment)

The following five comments were provided by MOS 63S personnel:

Control box cannon plug needs "test site" for maintenance (one comment)
Surge tank hose (one comment)
No. 1 glo-plug is hard to reach (one comment)
Fuel supply lines (one comment)
Oil cooler needs quick disconnect (one comment)

No comments were provided by MOS 63Y personnel.

No comments were provided by MOS 63E personnel.

CN-2 Are there any HMMWV electrical or other connectors that can be accidentally inserted into a wrong mating connector during maintenance procedures?

Yes	15%
No	52%
No Comment	33%

The following nine comments were provided by MOS 63B personnel:

External lights can lose tags and may be hooked up wrong (three comments)
The wires on top of the ejection pump (one comment)
Fuel pumps vent and air cleaner vent are interchangeable (one comment)
All rubber connectors need color coding (one comment)
Instrument panel lighting wires (one comment)
Power and ground wires for gauges (one comment)
Wires for neutral safety switch and parking brake switch (one comment)

No comments were provided by MOS 63S personnel:

The following comment was provided by MOS 63Y personnel:

200-amp generator wires (one comment)

The following comment was provided by MOS 63E personnel:

Headlight-tail lights can be hooked up wrong (one comment)

CN-3 List any HMMWV connectors that can become loose or disconnected on their own. Describe connectors-components.

The following ten comments were provided by MOS 63B personnel:

Alternator bolts (three comments)
Starter bolts (three comments)
15-mm cap bolts on half shaft can come loose (two comments)
Glo-plug connectors (one comment)
Control box connector can loosen (one comment)

No comments were provided by MOS 63S personnel.

The following comment was provided by MOS 63Y personnel:

Ground wire at hood for lights (one comment)

The following comment was provided by MOS 63E personnel:

Battery terminals can loosen (one comment)

CN-4 Are there any HMMWV components where there is inadequate service loop in the connector lines or awkward twist or routing paths, which make them difficult to service, connect, or disconnect?

Yes	16%
No	48%
No Comment	36%

The following six comments were provided by MOS 63B personnel:

Tail light wiring (two comments)
Instrument panel wires too short to open panel for service (one comment)
Speedometer cable too short (one comment)
Control box wiring (one comment)
Fuel tank connector lines (one comment)

The following two comments were provided by MOS 63S personnel:

Tail light wiring (two comments)

No comments were provided by MOS 63Y personnel.

The following comment was provided by MOS 63E personnel:

Instrument panel wiring too short to open panel (one comment)

CN-5 What are the most significant improvements that could be made in the HMMWV to reduce the time and effort required to service, connect, and disconnect component connectors? List improvements and estimate time reduction. No rating scale was included with this question.

The following 13 comments were provided by MOS 63B personnel:

Fuel tank access panel (four comments)
Color code connectors (four comments)
Get rid of connector plugs (three comments)
Lengthen speedometer cable-panel wires (one comment)
Quick disconnect for fuel filter (one comment)

The following comment was provided by MOS 63S personnel:

Get rid of old style connectors (one comment)

No comments were provided by MOS 63Y personnel.

No comments were provided by MOS 63E personnel.

Labeling-Marking

LM-1 Are there any labels or marking on the HMMWV or its components or their connecting lines that degrade maintenance procedures because

A Size, location, contrast, or fading makes it difficult to read the data provided. YES 32%, NO 68%
B The label or marking is missing. YES 30%, NO 70%
C The label or marking is hidden. YES 31%, NO 69%
D The data on the label or marking are incorrect. YES 0, NO 100%

No comments were provided by MOS 63B personnel.

No comments were provided by MOS 63S personnel.

No comments were provided by MOS 63Y personnel.

No comments were provided by MOS 63E personnel.

LM-2 List any HMMWV test points, reservoirs, auxiliary equipment, controls and displays, or other areas of concern that require labels or marking or are inadequately identified. Describe problems for each item.

No comments were provided by MOS 63B personnel.

No comments were provided by MOS 63S personnel.

No comments were provided by MOS 63Y personnel.

No comments were provided by MOS 63E personnel.

LM-3 List any HMMWV safety hazards or cautions, including weight-lifting limits for removable vehicle components, which are not properly labeled or marked, and therefore degrade operation or maintenance. Describe problem for each item.

The following five comments were provided by MOS 63B personnel:

Starter removal is difficult (three comments)
The battery is heavy (one comment)
Radio replacement data plates needed (one comment)

No comments were provided by MOS 63S personnel.

No comments were provided by MOS 63Y personnel.

The following comment was provided by MOS 63E personnel:

Starter is heavy and hard to replace.

LM-4 List any problems you have experienced in reading labels or markings while wearing MOPP IV face masks or other protective equipment, which degraded HMMWV maintenance procedures. Describe problem for each item.

The following eight comments were provided by MOS 63B personnel:

Never wore MOPP IV while doing HMMWV maintenance (eight comments)

No comments were provided by MOS 63S personnel.

The following comment was provided by MOS 63Y personnel:

Found it difficult to read battery positive-negative terminals (one comment)

No comments were provided by MOS 63E personnel.

LM-5 What other problems or comments relating to HMMWV labels and markings have you experienced? List and explain.

The following two comments were provided by MOS 63B personnel:

Labels fall off or get painted over (one comment)
Battery terminals should be more clearly labeled concerning which one to connect-disconnect first (one comment)

No comments were provided by MOS 63S personnel.

No comments were provided by MOS 63Y personnel.

No comments were provided by MOS 63E personnel.

Lifting-Carrying

LC-1 List any HMMWV components that need lifting handles (to remove from vehicle or to carry) or have handles that are too small or badly placed for personnel to safely and effectively manipulate those components. Describe problem for each item.

The following five comments were provided by MOS 63B personnel:

The engine hood needs better handles (three comments)
The 200-amp to 400-amp alternator needs handles (one comment)
The starter needs handles (one comment)

No comments were received from MOS 63S personnel.

The following comment was received from MOS 63Y personnel:

Alternators need lifting handle (one comment).

No comments were provided by MOS 63E personnel.

LC-2 List any HMMWV component that includes handles but is too heavy or bulky to be lifted by the number of personnel specified. Describe problem for each item.

The following two comments were provided by MOS 63B personnel:

The batteries are difficult to replace—no room for two people in space provided (two comments)

No comments were provided by MOS 63S personnel.

No comments were provided by MOS 63Y personnel.

No comments were provided by MOS 63E personnel.

LC-3 Do you need additional equipment (e.g., hoist, crane, lever, etc.) which is not provided at your duty station, to lift, remove, or replace HMMWV components?

YES	8%
NO	92%

The following three comments were provided by 63B personnel:

Need more durable floor jacks (two comments)
Need power tools, such as impact wrenches (one comment)

The following comment was provided by 63S personnel:

Need better jack (one comment)

No comments were provided by MOS 63Y personnel.

No comments were provided by MOS 63E personnel.

LC-4 Do you know of any alternate procedure that would safely and effectively reduce the time and effort required to lift or carry HMMWV components?

YES	11%
NO	89%

The following five comments were provided by MOS 63B personnel:

Raise battery box (one comment)
Special bolts to replace lower belt housing and engine (one comment)
Slide transmission back on bolts for flywheel removal (one comment)
Use lift for starter removal (one comment)
Use dolly cart to transport heavy equipment (one comment)

No comments were provided by MOS 63S personnel.

No comments were provided by MOS 63Y personnel.

No comments were provided by MOS 63E personnel.

LC-5 What other problems or concerns relating to the HMMWV components' lifting-carrying have you experienced? List problem and component.

The following seven comments were provided by MOS 63B personnel:

Lifting the alternator and starter (six comments)
Power steering and generator brackets (bolting) (one comment)

No comments were provided by MOS 63S personnel.

No comments were provided by MOS 63Y personnel.

No comments were provided by MOS 63E personnel.

Remove-Replace

RR-1 Which HMMWV components that are maintained at your duty station are the most difficult and time consuming to remove and replace? List components and problems.

The following 38 comments were provided by MOS 63B personnel:

Starter (nine comments)
Alternator (seven comments)
Glo-plugs (five comments)
Fuel tank (five comments)
Power steering pump (two comments)
Radiator (two comments)
Engine oil-transmission cooler (two comments)
Geared hubs (one comment)
Ball joints (one comment)
Exhaust system (one comment)
Manifold gaskets (one comment)
Differential seals (one comment)
Half shaft (one comment)

The following five comments were provided by MOS 63S personnel:

Glo-plug controller (one comment)
Fan shroud (one comment)
Ball joints (one comment)
Power steering pump (one comment)
Starter (one comment)

The following comment was provided by MOS 63Y personnel:

Fan shroud (one comment)

The following 2 comments were provided by MOS 63E personnel:

Glo-plug controller (one comment)
Gear hubs (one comment)

RR-2 Are these and other HMMWV components that you deal with, readily available as replacement parts at your duty station? If no, list components and problems with non-availability.

YES	64%
NO	36%

The following 13 comments were provided by MOS 63B personnel:

Starter (two comments)
Glo-plug controller (two comments)
Generator bracket (two comments)
Radiator crossover (one comment)
Exhaust (one comment)
Geared hub (one comment)
Half shaft (one comment)
Ball joints (one comment)
Fuel tank (one comment)
Fan shroud (one comment)

The following five comments were provided by MOS 63S personnel:

Glo-plugs (two comments)
Geared hub (one comment)
Half shaft (one comment)
Ball joints (one comment)

No comments were provided by MOS 63Y personnel.

No comments were provided by MOS 63E personnel.

RR-3 When you order HMMWV components, are there any forms or records that need to be revised or updated because

a They do not contain all the needed information

YES	15%
NO	85%

b They are difficult and time consuming to complete

YES	13%
NO	87%

c They require information that is duplicated elsewhere

YES	12%
NO	88%

If yes on any of the above, identify the form and the problem.

The following six comments were provided by MOS 63B personnel:

Put stock number next to part number (three comments)
Manuals have too many changes (one comment)
Manuals do not have updated changes (one comment)
Manuals do not have all stock numbers (one comment)

The following comment was provided by MOS 63S personnel:

FORM 5899E needs revision (one comment)

The following comment was provided by MOS 63Y personnel:

Put stock number and part number in same place (one comment)

No comments were provided by MOS 63E personnel.

RR-4 How often does delayed receipt of HMMWV components keep the vehicle from being mission ready?

Never	12%
Seldom	38%
Occasionally	37%
Frequently	13%

List problems for occasionally or frequently.

The following 11 comments were provided by MOS 63B personnel:

Delays due to Army channels (one comment)
Problem getting 200-amp alternators (one comment)
Glo-plug controller (one comment)
Starters (one comment)
Brake parts (one comment)
Surge tanks (one comment)
Half shafts (one comment)
Tie rods (one comment)

Power steering gear box (one comment)
Batteries (one comment)
Steering column (one comment)

The following three comments were provided by MOS 63S personnel:

Glo-plugs (one comment)
Gear hub (one comment)
Brake caliper (one comment)

No comments were provided by MOS 63Y personnel.

The following two comments were provided by MOS 63E personnel.

All major parts are delayed (one comment)
More parts should be kept on hand (one comment)

RR-5 List the most significant improvements that could be made to reduce the time and effort required to remove or replace HMMWV components.

The following 17 comments were provided by MOS 63B personnel:

Fuel tank needs access panel (three comments)
Need better glo-plug control box (three comments)
Mechanics need better tools (two comments)
Need more space in engine compartment (two comments)
Make starter more compact (two comments)
Need quick disconnects (two comments)
Keep parts on hand (one comment)
Better manuals are needed (one comment)
Fan shroud and manifold should be revised (one comment)

The following three comments were provided by MOS 63Y personnel:

Improve Army supply system (one comment)
Improve manuals—more pictures (one comment)
Better equipment—more work space (one comment)

No comments were provided by MOS 63Y personnel.

The following two comments were provided by MOS 63E personnel:

Make components easier to access (one comment)
Keep more parts on hand (one comment)

Operational Checks

OC-1 Which HMMWV components are the most difficult to perform operational checks on? List components and describe problems.

The following six comments were provided by MOS 63B personnel:

Starter hard to reach (two comments)
Radiator overflow tanks (one comment)
Injector pump (one comment)
Generator (one comment)
Geared hub (one comment)

No comments were provided by MOS 63S personnel.

No comments were provided by MOS 63Y personnel.

The following three comments were provided by MOS 63E personnel:

The glo-plug controller (one comment)
The flywheel—must remove shroud (one comment)
Starter (one comment)

OC-2 Which HMMWV operational checks that you perform do you feel should be performed by another MOS? List operational checks you feel another MOS should do.

The following three comments were provided by MOS 63B personnel:

Changing oil should be the operator's job (one comment)
Seatbelts (one comment)
The new mirrors (one comment)

No comments were provided by MOS 63S personnel.

No comments were provided by MOS 63Y personnel.

No comments were provided by MOS 63E personnel.

OC-3 Do you know of any alternate methods that would safely and effectively reduce the time and effort required to perform specific operational checks on the HMMWV? List such methods and estimate time it will save.

No comments were provided by MOS 63B personnel.

No comments were provided by MOS 63S personnel.

No comments were provided by MOS 63Y personnel.

The following comment was provided by MOS 63E personnel:

Install high impact plastic sight glasses in the differentials, geared hub, and transfer case to see fluid level in each, for quick easy maintenance (one comment)

OC-4 Do you need any equipment that is not provided at your duty station, which could reduce the time and effort required to perform operational checks or increase the quality of the operational checks performed?

YES	19%
NO	81%

If yes, list and describe such equipment, estimate time savings and quality differences you expect if equipment were available.

The following nine comments were provided by MOS 63B personnel:

Better tools—power tools (three comments)
3/8-inch drive socket set (two comments)
Need a central tire inflation system tester (one comment)
Battery load tester (one comment)
Fuel tank gauge sender tester (one comment)
PRO-LINK 9000 (one comment)

The following three comments were provided by MOS 63S personnel:

Better tools (e.g., 3/8-inch drive socket set) (three comments)

No comments were provided by MOS 63Y personnel.

No comments were provided MOS 63E personnel.

OC-5 What is the most significant improvement that could be made to improve the operational check process on the HMMWV?

The following seven comments were provided by MOS 63B personnel:

Operators need to improve their preventive maintenance checks and services (PMCS) (three comments)
Provide self-test when vehicle is initially turned on (one comment)
Need PRO-LINK (one comment)
Better training for mechanics (one comment)
Better tools for mechanics (one comment)

The following three comments were provided by MOS 63S personnel:

Operators need to do better PMCS (one comment)
Add PRO-LINK (one comment)
Mechanics should receive better training (one comment)

No comments were provided by MOS 63Y personnel.

The following comment was provided by MOS 63E personnel:

Operators need to do good PMCS (one comment)

Technical Manuals

TM-1 Are the HMMWV technical manuals provided to you easy to follow and do they have adequate instructions and diagrams to address safe and effective servicing, removal, and replacement procedures?

YES	72%
NO	28%

If no, describe specific problems.

The following 15 comments were provided by MOS 63B personnel:

Troubleshooting chart hard to follow (five comments)
Need updated changes to manual (two comments)
Put stock number next to part number (two comments)
Glo-plug system troubleshooting (one comment)
Charger system troubleshooting (one comment)
Replace manuals with computer (one comment)
Starter system procedure (one comment)
Need more pictures in “10” manual (one comment)
More details on tire installation (one comment)

The following five comments were provided by MOS 63S personnel:

Troubleshooting chart not clear (two comments)
Charger system troubleshooting needs improvement (one comment)
Stock number should be on same page as part number (one comment)
Manuals not clear (one comment)

The following comment was provided by MOS 63Y personnel:

Stock and part numbers together on same page (one comment)

The following comment was provided by MOS 63E personnel:

Need more pictures to make task clear (one comment)

TM-2 Are there any specific HMMWV components, equipment, or procedures that are not correctly or adequately identified in these manuals?

YES	19%
NO	81%

If yes, describe specific problems.

The following 10 comments were provided by MOS 63B personnel:

Need more pictures for component identification (one comment)
Heater temp. cable routing unclear (one comment)
Glo-plug tasks (one comment)
Rubber seal inside yokes not shown (one comment)
Changing radiator (one comment)
Power steering procedures (one comment)
Wheeled hub procedures (one comment)
100-amp generator troubleshooting is vague (one comment)
Radial tire installation needs more detail (one comment)
Troubleshooting flow chart hard to find specific problem (one comment)

The following two comments were provided by MOS 63S personnel:

Procedures vague for power steering (one comment)
Procedures unclear for wheeled hub (one comment)

No comments were provided for MOS 63Y personnel:

The following comment was provided by MOS 63E personnel:

"10" manuals need more illustrations to identify components (one comment)

TM-3 Are the safety warnings and cautions within the HMMWV manuals adequate?

YES	100%
NO	0%

If no, describe specific problems.

No comments were provided by MOS 63B personnel.

No comments were provided by MOS 63S personnel.

No comments were provided by MOS 63Y personnel.

No comments were provided by MOS 63E personnel.

TM-4 Are the weight-lifting limitations for removing and carrying components that require two or more personnel, correctly identified in the HMMWV manuals?

YES	89%
NO	11%

If no, describe specific problems.

The following two comments were provided by MOS 63B personnel:

Never heard of limits (one comment)
Some things are heavy and some are awkward (one comment)

The following comment was provided by MOS 63S personnel:

Handles may be needed when converting canvas to ballistic (one comment)

No comments were provided by MOS 63Y personnel.

No comments were provided by MOS 63E personnel.

TM-5 List most significant improvements that could be made to reduce the time and effort required to effectively use the HMMWV manuals.

The following nine comments were provided by MOS 63B personnel:

Stock number and part number same page (three comments)
Need manuals on tape (one comment)
Change to automated system (one comment)
Page holes should be reinforced (one comment)
Provide quick references for common problems (one comment)
Make troubleshooting chart more specific (one comment)
Timely description of updates needed (one comment)

The following three comments were provided by MOS 63S personnel:

Stock-part number same page (two comments)
Use contact test set (CTS) to reduce time looking through manuals (one comment)

The following comment was provided by MOS 63Y personnel:

Stock-part number on same page (one comment)

The following comment was provided by MOS 63E personnel:

Need updated manuals (one comment)

Training

TN-1 What areas of training (e.g., theory, hands-on, etc.) for HMMWV maintenance need to be improved? List specific areas and problems.

The following 11 comments were provided by MOS 63B personnel:

Need better PMCS for operators (three comments)
Need specific training, such as electrical troubleshooting (three comments)
Need hands-on training (two comments)
Need more training on basic principles of hardware (two comments)
Need to teach the soldier task performance procedures (one comment)

The following six comments were provided by MOS 63S personnel:

Need to learn more about vehicle (two comments)
Need troubleshooting training (two comments)
Need training on wheel components (one comment)
Need hands-on instruction (one comment)

The following comment was provided by MOS 63Y personnel:

Need training for electrical problems (one comment)

The following three comments were provided by MOS 63E personnel:

Training should be based on how components work (one comment)
Need more operator PMCS (one comment)
Electrical troubleshooting needed (one comment)

TN-2 Rate the adequacy of the training that you received in the Army which concerns HMMWV maintenance

Very Adequate	14%
Moderately Adequate	43%
Borderline	19%
Moderately Inadequate	16%
Very Inadequate	8%

List comments concerning your training as it affects the HMMWV.

The following 22 comments were provided by MOS 63B personnel:

Need more training (20 comments)
Need more extensive training (two comments)

The following comment was provided by MOS 63S personnel:

Need more training (one comment)

The following comment was provided by MOS 63Y personnel:

Need more training (one comment)

The following comment was provided by MOS 63E personnel:

Need more training (one comment)

TN-3 Were there any areas of HMMWV training that you received that you later found to be wrong?

YES	0%
NO	100%

If yes, explain.

No comments were provided by MOS 63B personnel.

No comments were provided by MOS 63S personnel.

No comments were provided by MOS 63Y personnel.

No comments were provided by MOS 63E personnel.

TN-4 How often have you performed HMMWV maintenance while wearing MOPP IV, arctic, or combat gear?

Never	59%
Seldom	21%
Occasionally	14%
Frequently	6%

Describe problems resulting from wearing such gear. Could such problems be reduced through additional training or improved component design?

The following five comments were provided by MOS 63B personnel:

Web gear gets hung up on things (two comments)
Hard to see labels through protective mask (one comment)
Bulky arctic hampers work (one comment)
Too awkward in any kind of protective clothing (one comment)

The following comment was provided by MOS 63S personnel:

Only during training exercises (one comment)

No comment was provided by MOS 63Y personnel.

No comment was provided by MOS 63E personnel.

TN-5 Do you know of any alternate procedures that would safely and effectively reduce the time and effort required to perform any maintenance task on the HMMWV as compared to the way you were trained?

YES	11%
NO	89%

If yes, explain.

The following three comments were provided by MOS 63B personnel:

The CTS (one comment)
Use fielded personnel's experiences in school lesson plan (one comment)
Improve training (one comment)

The following comment was provided by MOS 63S personnel:

Let the student tear the vehicle down and rebuild it (one comment)

No comment was provided by MOS 63Y personnel.

No comment was provided by MOS 63E personnel.

Safety Problems

SA-1 Have you experienced any of the following safety problems while performing the tasks listed?

Troubleshooting

Hot surfaces

Yes	52%
No	48%

Sharp edges

Yes	40%
No	60%

Electrical hazards

Yes	30%
No	70%

Contact moving parts

Yes	29%
No	71%

Fluid spills

Yes	35%
No	65%

The following comments were provided by the MOSs shown:

	MOS			
	63B	63S	63Y	63E
Working near a hot engine can cause burns	6	1	0	1
Fluid spills can cause slip and fall injuries	2	1	1	1
Damaged vehicle body parts can cause cuts	2	1	0	0
Hose clamps have sharp edges and can cut	1	1	0	1
Hot exhaust can cause burns	1	1	0	0
Generator can be an electrical hazard	1	0	0	0
The engine fan-belts can be a problem	1	0	0	0

SA-1

Accessing Components—any problems?

Hot surfaces

Yes	65%
No	35%

Sharp edges

Yes	31%
No	69%

Electrical hazards

Yes	20%
No	80%

Contact moving parts

Yes	23%
No	77%

Fluid spills

Yes	37%
No	63%

The following comments were provided by the MOSs shown:

	MOS			
	63B	63S	63Y	63E
The engine has hot surfaces and can burn	4	1	0	0
Aluminum body parts sometimes sharp	2	1	0	1
Have to wait for the engine to cool before working on glo-plugs	1	1	0	1
Hot fluid comes out when removing components	1	0	1	0
Exhaust system is hot—causes serious burns	1	0	0	0
Generator should have diagnostic connector	1	0	0	0
Working near starter can be electrical hazard	1	0	0	0

SA-1

Fastening or Unfastening Components—any problems?

Hot surfaces

Yes	49%
No	51%

Sharp edges

Yes	47%
No	53%

Electrical hazards

Yes	48%
No	52%

Contact moving parts

Yes	43%
No	57%

Fluid spills

Yes	44%
No	56%

The following comments were provided by the MOSs shown:

	MOS			
	63B	63S	63Y	63E
Engine when it's hot	5	1	0	1
Exhaust system	1	0	0	1
Clamps on some hoses are sharp—can cut you	0	1	0	0
Connect-disconnect battery properly	0	1	0	0
Generator can be electrical hazard	0	1	0	0
Fluid spills take time to clean up and can cause accidents	0	1	0	0

SA-1

Connecting or Disconnecting Connectors—any problems?

Hot surfaces

Yes	50%
No	50%

Sharp edges

Yes	31%
No	69%

Electrical hazards

Yes	58%
No	42%

Contact moving parts

Yes	30%
No	70%

Fluid spills

Yes	43%
No	57%

The following comments were provided by the MOSs shown:

	MOS			
	63B	63S	63Y	63E
The engine can get hot enough to burn	2	3	0	4
Hose clamps—sharp	1	0	0	0
Generator—electrical hazard	0	1	0	0
Fluid spills can be hot	1	0	0	0

SA-1

Lifting or Carrying Components—any problems?

Hot surfaces

Yes	31%
No	69%

Sharp edges

Yes	63%
No	37%

Electrical hazards

Yes	20%
No	80%

Contact moving parts

Yes	10%
No	90%

Fluid spills

Yes	15%
No	85%

The following comments were provided by the MOSs shown:

	MOS			
	63B	63S	63Y	63E
Adjacent parts may be hot	10	1	1	0
It is best to wait unit parts cool	8	2	0	1
Fluid spills can make parts slippery	3	0	0	1
Adjacent parts may be sharp	2	0	0	0

SA-1

Remove or Replace Components—any problems?

Hot surfaces

Yes	50%
No	50%

Sharp edges

Yes	43%
No	57%

Electrical hazards

Yes	30%
No	70%

Contact moving parts

Yes	43%
No	57%

Fluid spills

Yes	42%
No	58%

The following comments were provided by the MOSs shown:

	MOS			
	63B	63S	63Y	63E
Vehicle body parts have sharp edges when damaged	1	1	1	0
Have received burns removing components from engine	2	0	0	0
Adjacent exhaust components could cause burns	0	0	0	1
Fluid spills can make parts slippery	1	0	0	0

SA-1

Perform Operational Checks—any problems?

Hot surfaces

Yes	59%
No	41%

Sharp edges

Yes	42%
No	58%

Electrical hazards

Yes	69%
No	31%

Contact moving parts

Yes	43%
No	57%

Fluid spills

Yes	24%
No	76%

The following comments were provided by the MOSs shown:

	MOS			
	63B	63S	63Y	63E
When engine is running during check, it's hot	10	0	0	1
Exhaust may be contacted during check	8	1	0	0
Since electrical components operational, there is a hazard	6	0	1	1
Moving fan and belts—hazard during check	4	1	0	1
Fluid spills cause slippery surfaces	1	1	0	0

The Effects of Clothing

AOC-1 Have you had any problems performing the following tasks while wearing the gear listed below?

Troubleshooting

MOPP IV

Yes	20%
No	5%
No Experience	75%

Arctic

Yes	25%
No	5%
No Experience	70%

Combat Gear

Yes	45%
No	5%
No Experience	50%

Fatigues

Yes	15%
No	75%
No Experience	15%

Shop Overalls

Yes	15%
No	75%
No experience	10%

The following comments were provided by the MOSs shown:

	MOS			
	63B	63S	63Y	63E
Protective gear just gets in the way	8	1	1	1
Fluid spills can cause slip and fall	2	1	1	1
Have to take off combat gear—snags on everything	2	0	1	0
Kevlar® not meant to fit under dash or hood	1	0	1	1
Arctic gear too bulky for good work	1	0	0	0
Generator can be an electrical hazard	1	0	0	0
The engine fan-belts can be problem	1	0	0	0

AOC-1

Accessing Components—any problems?

MOPP IV

Yes	25%
No	0%
No Experience	75%

Arctic

Yes	30%
No	0%
No Experience	70%

Combat Gear

Yes	40%
No	10%
No Experience	50%

Fatigues

Yes	5%
No	80%
No Experience	15%

Shop Overalls

Yes	5%
No	85%
No experience	10%

The following comments were provided by the MOSs shown:

	MOS			
	63B	63S	63Y	63E
Shop overalls are what I wear	10	0	0	1
Webbing gets caught on things	2	1	0	0
Arctic mittens must be removed	1	0	0	0

AOC-1

Fastening or Unfastening Components—any problems?

MOPP IV

Yes	15%
No	10%
No Experience	75%

Arctic

Yes	25%
No	5%
No Experience	70%

Combat Gear

Yes	15%
No	35%
No Experience	50%

Fatigues

Yes	5%
No	80%
No Experience	15%

Shop Overalls

Yes	5%
No	85%
No experience	10%

The following comments were provided by the MOSs shown:

	MOS			
	63B	63S	63Y	63E
Protective gear too bulky to work under hood	5	0	1	2
It is difficult to handle tools with gloves on	2	1	0	1
MOPP IV face mask hard to see labels	1	0	0	0

AOC-1

Connecting or Disconnecting Connectors—any problems?

MOPP IV

Yes	20%
No	5%
No Experience	75%

Arctic

Yes	30%
No	0%
No Experience	70%

Combat Gear

Yes	50%
No	0%
No Experience	50%

Fatigues

Yes	15%
No	70%
No Experience	15%

Shop Overalls

Yes	15%
No	75%
No experience	10%

The following comments were provided by the MOSs shown:

	MOS			
	63B	63S	63Y	63E
Area provided under hood-instrument panel too small	5	1	1	1
Must take off gloves to use tools-test equipment	2	3	0	1
Webbing gets caught on things	1	0	0	0

AOC-1

Lifting or Carrying Components—any problems?

MOPP IV

Yes	0%
No	25%
No Experience	75%

Arctic

Yes	0%
No	30%
No Experience	70%

Combat Gear

Yes	20%
No	30%
No Experience	50%

Fatigues

Yes	0%
No	85%
No Experience	15%

Shop Overalls

Yes	0%
No	90%
No experience	10%

The following comments were provided by the MOSs shown:

	MOS			
	63B	63S	63Y	63E
Combat gear inhibits lifting in confined spaces	2	0	0	0

AOC-1

Remove or Replace Components—any problems?

MOPP IV

Yes	15%
No	10%
No Experience	75%

Arctic

Yes	25%
No	5%
No Experience	70%

Combat Gear

Yes	15%
No	35%
No Experience	50%

Fatigues

Yes	5%
No	80%
No Experience	15%

Shop Overalls

Yes	5%
No	85%
No experience	10%

The following comments were provided by the MOSs shown:

	MOS			
	63B	63S	63Y	63E
MOPP IV face mask hard to see labels	4	0	1	2
Gloves interfere with handling tools-test equipment	2	1	0	2
Webbing snags on things	1	0	0	0

AOC-1

Perform Operational Checks—any problems?

MOPP IV

Yes	0%
No	0%
No Experience	100%

Arctic

Yes	0%
No	0%
No Experience	100%

Combat Gear

Yes	0%
No	0%
No Experience	100%

Fatigues

Yes	8%
No	85%
No Experience	7%

Shop Overalls

Yes	5%
No	90%
No experience	5%

The following comments were provided by the MOSs shown:

	MOS			
	63B	63S	63Y	63E
With systems running during check, bulky clothing is a real hazard	3	1	0	1
Difficult to handle diagnostic equipment	2	1	1	1
Fluid spills degrade protective clothing	1	0	0	0

Personnel Requirements

PR-1 and PR-2 How often do you need more personnel-fewer personnel than is specified in the technical manual to assist you in performing the following tasks?

Troubleshooting

Never

More personnel	30%
Fewer personnel	60%

Sometimes

More personnel	50%
Fewer personnel	25%

Half the time

More personnel	10%
Fewer personnel	5%

Most times

More personnel	5%
Fewer personnel	5%

All the time

More personnel	5%
Fewer personnel	5%

The following comments were provided by the MOSs shown:

	MOS			
	63B	63S	63Y	63E
Some jobs just take more than one person	2	0	0	0
Sometimes another person just gets in the way	1	1	0	0
The number of people required depends on situation	0	1	0	0
Occasionally I need someone to operate the vehicle controls while I make measurements	1	0	0	0
One soldier to read manual-one to work	1	0	0	0

PR-1 and PR-2

Accessing Components—need more or fewer personnel?

Never

More personnel	40%
Fewer personnel	65%

Sometimes

More personnel	44%
Fewer personnel	20%

Half the time

More personnel	8%
Fewer personnel	6%

Most times

More personnel	4%
Fewer personnel	4%

All the time

More personnel	4%
Fewer personnel	5%

The following comments were provided by the MOSs shown:

	MOS			
	63B	63S	63Y	63E
Another person is useful at times	1	0	0	1
Sometimes there is no space for another person	1	0	0	0

PR-1 and PR-2

Fastening or Unfastening Components—need more or fewer personnel?

Never

More personnel	40%
Fewer personnel	71%

Sometimes

More personnel	38%
Fewer personnel	20%

Half the time

More personnel	10%
Fewer personnel	4%

Most times

More personnel	12%
Fewer personnel	5%

All the time

More personnel	0%
Fewer personnel	0%

The following comments were provided by the MOSs shown:

	MOS			
	63B	63S	63Y	63E
Some jobs need more hands	1	0	0	0
Need someone at times to hand in tools	1	0	0	0

PR-1 and PR-2

Connecting or Disconnecting Connectors—need more or fewer personnel?

Never

More personnel	48%
Fewer personnel	74%

Sometimes

More personnel	40%
Fewer personnel	15%

Half the time

More personnel	8%
Fewer personnel	2%

Most times

More personnel	2%
Fewer personnel	6%

All the time

More personnel	2%
Fewer personnel	3%

The following comments were provided by the MOSs shown:

	MOS			
	63B	63S	63Y	63E
Sometimes helper is needed to hold things	1	0	0	1
Need someone at times to fetch and carry	1	0	0	0

PR-1 and PR-2

Lifting or Carrying Components—need more or fewer personnel?

Never

More personnel	35%
Fewer personnel	58%

Sometimes

More personnel	52%
Fewer personnel	25%

Half the time

More personnel	10%
Fewer personnel	7%

Most times

More personnel	2%
Fewer personnel	8%

All the time

More personnel	1%
Fewer personnel	2%

The following comments were provided by the MOSs shown:

	MOS			
	63B	63S	63Y	63E
Always need help carrying things to job	0	1	0	1
Things like starter are difficult to lift	1	0	0	0

PR-1 and PR-2

Remove or Replace Components—need more or fewer personnel?

Never

More personnel	25%
Fewer personnel	45%

Sometimes

More personnel	35%
Fewer personnel	25%

Half the time

More personnel	15%
Fewer personnel	5%

Most times

More personnel	15%
Fewer personnel	13%

All the time

More personnel	10%
Fewer personnel	12%

The following comments were provided by the MOSs shown:

	MOS			
	63B	63S	63Y	63E
I need a helper at times	1	0	0	0
Need more people sometimes	1	0	0	0

PR-1 and PR-2

Perform Operational Checks—need more or fewer personnel?

Never

More personnel	45%
Fewer personnel	70%

Sometimes

More personnel	30%
Fewer personnel	20%

Half the time

More personnel	15%
Fewer personnel	5%

Most times

More personnel	8%
Fewer personnel	5%

All the time

More personnel	2%
Fewer personnel	0%

The following comments were provided by the MOSs shown:

	MOS			
	63B	63S	63Y	63E
With systems running, need more people	1	2	0	1
Need someone to operate controls	2	0	0	0

Tool Requirements

TR-1 While performing the following tasks, list any tools that you need that are not provided in your standard toolbox.

Troubleshooting

Need a wheeled creeper (63B) (1)

Accessing Components

3/8-inch drive ratchet set (63B, 63S, 63E) (5)
Need longer wrenches (63B) (2)
Allen wrench-sockets (63B) (2)
Provide all the tools in manual (63B) (1)
Spindle nut sockets (63B) (1)

Fastening-Unfastening Components

3/8-inch drive ratchet set (63B, 63S, 63E) (5)
Need longer wrenches (63B) (1)
Provide all the tools in manual (63B) (1)
Spindle nut sockets (63B) (1)
Allen wrenches (63B) (1)

Connecting or Disconnecting Connectors

Need larger wrenches (63B) (1)
Provide all tools in manual (63B) (1)
Need wire stripper (63B) (1)

Lifting or Carrying Components

Need portable wheeled dolly to carry parts (63B) (1)

Remove or Replace Components

Need some kind of lift when mounting starter (63B) (1)

Performing Operational Checks

Need better tools (63B) (1)

Test Equipment Requirements

TER-1 While performing the following tasks, list any test equipment you need that is not provided to you.

Troubleshooting

Need better multimeter (63B) (3)
Need better test equipment (e.g., PRO-LINK 9000) (63B) (2)
Need long leads for multimeter (63B) (1)
Need load tester (63B (1)
Need pressure tester (63B) (1)

Accessing Components

Need accessible diagnostic test points on vehicle (63B) (2)
Need centralized diagnostic panel (63B) (1)

Fastening or Unfastening Components

Need above diagnostic test points to "come off" with the component and not require separate removal (63B) (1)

Connecting or Disconnecting Connectors

Need more manageable connectors to aid testing (63B) (1)

Lifting or Carrying Components

Need easy portable, easy set-up diagnostic equipment (63B) (1)

Remove or Replace Components

No comment

Performing Operational Checks

Need better test equipment (e.g., PRO-LINK 9000) (63B) (1)
Need better multimeter with long leads (63B) (1)
Need load tester (63B) (1)
Need pressure test set (63B) (1)

Overall Difficulty of Maintenance

OM-1 Overall, rate how easy or difficult it is to perform the following tasks on the HMMWV:

Troubleshooting

Very Difficult	13%
Moderately Difficult	17%
Borderline	27%
Moderately Easy	27%
Very Easy	16%

List comments concerning troubleshooting:

Glo-plug system difficult to troubleshoot (63B) (3)
Mechanics need more training in troubleshooting (63B) (2)
Fuel tank problems easy to correct but hard to get at (63B) (2)
Need better schematics-fault charts (63B) (2)
Some jobs are more time consuming than difficult (63B) (1)

Accessing Components—easy or difficult to perform maintenance

Very Difficult	15%
Moderately Difficult	16%
Borderline	26%
Moderately Easy	28%
Very Easy	15%

List comments concerning accessing components:

Fuel tank sending unit needs access hatch (63B) (5)
Glo-plug access difficult (63B) (4)
Starter-alternator hard to access (63B) (3)
Dashboard access to gauges, etc. (63B) (2)
Power steering pump access difficult (63B) (1)

Fastening or Unfastening Components—easy or difficult to perform maintenance

Very Difficult	4%
Moderately Difficult	25%
Borderline	28%
Moderately Easy	25%
Very Easy	18%

List comments concerning fastening or unfastening components:

Alternator-starter bolts (63B) (3)
Engine hood latches difficult (63B) (2)
Canvas covers difficult to fasten (63B) (2)
Brake caliper bolt removal (63S) (1)

Connecting or Disconnecting Connectors—easy or difficult to perform maintenance

Very Difficult	0%
Moderately Difficult	19%
Borderline	27%
Moderately Easy	35%
Very Easy	19%

List comments concerning connecting or disconnecting connectors:

Glo-plug controller needs better connectors (63E, 63B) (3)
Instrument panel gauges need better connectors (63B) (1)
Power steering pump needs quick disconnect (63B) (1)
Gear hub vent tube needs better connector (63B) (1)

Lifting or Carrying Components—easy or difficult to perform maintenance

Very Difficult	0%
Moderately Difficult	19%
Borderline	29%
Moderately Easy	29%
Very Easy	23%

List comments concerning lifting or carrying components:

The starter is difficult to replace (63B) (2)
The batteries are difficult to replace (63B) (1)

Remove or Replace Components—easy or difficult to perform maintenance

Very Difficult	0%
Moderately Difficult	28%
Borderline	48%
Moderately Easy	24%
Very Easy	0%

List comments concerning removing or replacing connectors:

The starter is difficult to replace (63B) (2)
Fuel tank components hard to get at (63B) (2)
Glo-plugs hard to replace (63B) (1)
Gear hubs difficult to replace (63B) (1)
Power steering pump (63B) (1)
Radiator (63B)(1)
Ball joints (63B)(1)
Engine oil or transmission cooler (63B) (1)
Half shaft (63B) (1)

Performing Operational Checks—easy or difficult to perform maintenance

Very Difficult	0%
Moderately Difficult	23%
Borderline	36%
Moderately Easy	21%
Very Easy	20%

List comments concerning operational checks:

Fuel tank sender unit (63B) (4)
The starter and generator are hard to get at (63B) (2)
Geared hub (63E, 63B) (2)
Injector pump (63B) (1)

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Maintenance operations influence vehicle effectiveness during the full range of required missions. These operations are essential to ensure that the vehicle systems are mission ready and coincide with the needs of the soldier.

In order to identify maintainability-related shortfalls for the high mobility multipurpose wheeled vehicle, a survey was conducted of 89 field site maintenance personnel.

The primary problems identified during this survey were troubleshooting preferences, the need for improved component access, time-consuming fastener and connectors, lifting and carrying difficulties, problems with labels and marking, and operational checks.

It is recommended that new vehicle systems take these items into consideration to enhance maintenance operations thus to increase mission performance and to reduce operation and sustainment costs.

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